The Informed Traveller:
A Proposed Travel Demand Management Intervention Technique

by

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ABSTRACT

It is widely believed that the average private vehicle user does not perceive their cost of travel accurately. This inaccurate perception of costs leads to a waste of resources and increased negative transport externalities. The focus of this research study was to investigate whether the sharing of actual personalised cost information could result in an alteration in travel behaviour, with the aim to assess whether sharing personalised cost information could be successfully implemented as a potential Travel Demand Management (TDM) measure.

The steps followed throughout this study included conducting surveys and tracking individual travel patterns before and after exposure to information regarding travel behaviour. The questionnaire administered before the tracking period contained questions about demographics, perceptions of transport, and vehicle characteristics. The vehicle characteristics questions, coupled with the use of global positioning system (GPS) devices for vehicle tracking, were included in order to assist in the calculation of actual monetary and environmental costs incurred. Following the original questionnaire, the individuals were tracked for a total period of four weeks. The first week was used to determine a "base" travel behaviour pattern as this week was prior to any information sharing. The subsequent weeks allowed for any change in travel behaviour to be identified due to the information sharing, which took place every Monday after the base week. In total, 23 participants took part in this study and had their private vehicles tracked during the four week period.

Participants also answered questions pertaining to their demographics and their perceptions regarding transportation. A second questionnaire was conducted after the four-week tracking period, this questionnaire assisted in identifying any shifts in perception regarding costs and emissions that the participants may have experienced. Of the 23 participants, 19 completed the final questionnaire. In addition, the dissertation attempted to determine whether certain subsets of the population were more likely to alter their travel behaviour patterns when exposed to certain motivational drivers. To achieve this, a secondary dataset was sourced from the Stellenbosch University Mobility Study, which took place in 2015 and, once cleaned, had a total of 853 participant responses that could be analysed (see Venter, Hitge, Krygsman & Thiart, 2018).

Unfortunately, due to the relatively small number of participants and short tracking period of this study, no statistically significant findings were uncovered. However, an in-depth investigation into the various trends and graphs identified was made. One indicator that holds great promise

regarding future TDM techniques such as this one was the shift in estimated cost, where a general increase of around 27% in perceived costs was experienced after participants were exposed to the informational invoices generated from the GPS tracking data. This indicator illustrates internalisation regarding the cost information shared with participants. If this internalisation is maintained for an extended period of time, it could potentially manifest into changes in travel behaviour. A longitudinal study of the 23 participants could potentially be conducted in the future to determine whether this manifestation did take place.

In conclusion it is recommended that any future studies relating to similar work should investigate the impacts of informational TDMs on either the same 23 participants or larger sample group sizes, across a longer period of time, to allow for the identification of statistically significant alterations in behaviour. In the future, electric vehicles will become more prominent among private vehicle users. The use of these vehicles would reduce environmental impacts and alter monetary cost calculations regarding vehicle usage. Due to this it is suggested that the impacts of electric vehicles also be included in future research.

Keywords: Travel Demand Management, informational measures, perceived costs, actual costs, environmental, GPS, questionnaires.

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ANOVA	Analysis of Variance
cc	Cubic centimetres
CO_2	Carbon dioxide
DESC	Departmental Ethics Screening Committee
GPS	Global Positioning System
GSM	Global System for Mobile Communications
NHREC	National Heath Research Ethics Committee
NMT	Non-motorised transport
OBD	On-Board Diagnostics
PTP	Personalised Travel Plan
SPSS	Statistical Package for the Social Sciences
Stats SA	Statistics South Africa
SUV	Sport utility vehicle
TDM	Travel Demand Management
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America

CHAPTER 1:
INTRODUCTION

1.1 INTRODUCTION

It is widely believed that the average private vehicle user does not perceive their cost of travel accurately, and generally underestimates the costs associated with using a private vehicle. Inaccurate perceptions of travel costs result in a suboptimal allocation of resources, and when left unregulated, these inaccurate perceptions could lead to market failure, which would have far-reaching implications for urban transportation systems and society as a whole. These implications include negative transport externalities, also known as social costs. In addition to private vehicle users not correctly perceiving their private costs associated with travel, it is believed that they do not fully incorporate social costs into their decision making. Not considering these social costs (negative externalities) further contributes to a suboptimal choice of transportation mode for an individual's purposes, thus further increasing the potential for wasted resources. For example, an individual may choose to utilise a private vehicle instead of public transport, even in the case where using the private vehicle would result in higher monetary and social costs.

When a market mechanism fails to reflect the scarcity value of exhaustible resources, it is often the government's responsibility to intervene. In doing so, the government may choose to "correct" the market by implementing various transport measures, which can be utilised on the supply or demand side of the market, thereby reducing any corresponding transport externalities. Various transport measures attempt to achieve this by various means.

Physical change measures aim to improve or expand current transport infrastructure, often requiring government intervention and substantial funding to be effective. Legal policy measures within the transport industry are utilised for the improvement of supply or the reduction of demand regarding transportation. These measures require government intervention in order to achieve successful implementation. The third and final type of measure is classified as an informational or educational measure. This measure aims to reduce demand for transportation by increasing the awareness and accessibility of information regarding negative aspects of transportation. This measure can also be used in educating individuals about the benefits that could be attained by changing patterns linked to travel behaviour, thereby attempting to alter their decision-making process (Gärling & Schuitema, 2007). These are all examples of measures that can be utilised to improve the overall transportation system or to address any market failure issues and resulting externalities.

Information sharing and educational measures are known as softer policies as they require no regulatory change, complex pricing policy, or physical alternation to transport infrastructure for implementation. These policies therefore require less capital investment, which is usually seen as a benefit. However, they are also known to be less effective than the alternative measures mentioned above. The main purpose of informational and educational measures is to reduce the overall demand for transport by informing individuals of the impacts of their decisions, while simultaneously teaching them how to make better decisions. This can be achieved through marketing campaigns or information-sharing exercises. As the main focus of these measures is generally geared towards managing the demand for transport, these measures are often referred to as Travel Demand Management (TDM) techniques.

As previously mentioned, it is believed that individuals tend to underestimate the costs associated with private vehicle usage (Gardner & Abraham, 2007). This inaccurate and incomplete cost perception of private vehicle users can be attributed to the following potential reasons: private vehicle users are not completely aware of the costs associated with transport, they are not aware of the fact that they themselves shift costs onto other road and non-road users, they think that only monetary costs (with respect to vehicle running costs) form part of their commuting costs, and potentially that they equate expenses to costs.

Due to this misinformation and inaccurate perception regarding transport costs, individuals do not appear to be well equipped when making decisions regarding their travel. It is therefore believed that if provided with accurate information, individuals may be assisted with internalising additional factors in their decision-making process, which would lead to altering their travel patterns. Therefore, it is proposed that the feasibility of informed "actual" and "personalised" monetary and environmental transport costs be shared with a group of individuals to measure the influence of this information on their travel patterns.

This research thus attempts to explore the impact of moral persuasion and appeal-based travel information on travel behaviour. This research could potentially assist in assessing the effectiveness of information-orientated TDM techniques and designing improved TDM strategies.

1.2 BACKGROUND

Private vehicle usage is the main cause of externalities related to road transport. These externalities include higher levels of congestion, atmospheric pollution, noise pollution, road accidents, and urban sprawl. In order to better understand what types of information may allude to an alteration of travel behaviour, a Mobility Study undertaken by Venter, Hitge, Krygsman & Thiart (2018) was conducted

with the aim of attempting to better understand the barriers and opportunities that participants encounter when travelling, as well as what this meant in terms of their safety and mobility. In the study participants were requested to complete a questionnaire which included questions relating to what types of information they perceived would lead to a change in travel behaviour. Analysis regarding this dataset has been included within this dissertation, unfortunately findings were inconclusive due to multiple limiting factors. As such, focus regarding information sharing shifted towards other studies. Jensen (1999) stated that many individuals feel concerned about the environment and understand that their private vehicle travel patterns have a negative impact on the environment.

Jensen (1999) further stated that even though they understand that they influence the environment, individuals are unwilling to alter their own travel behaviour. This is explained as being due to most individuals not believing it is effective or fair that they alone should change. This belief is further compounded by feelings that they alone have an insignificant impact on environmental change as long as their "neighbours" are not also altering their patterns for social benefit. It seems that the common good associated with environmental benefits may not be sufficiently motivational to induce behavioural change. Individuals will only really reap the advantages of reducing environmental costs if they do so as a social collective, and only if they do so continuously; these factors may inhibit the willingness of individuals to commit to transport behaviour pattern shifts. Therefore, the impact of a TDM measure, which focuses purely on the environmental aspect, will not be effective in its own right.

A more effective measure would be to not only focus on the environmental aspect of transport, which is generally seen as a societal impact and often hidden from motorists as a cost, but ideally to include additional information that links to potential individual benefits as well. Seeing as environmental information would inform private vehicle users of their societal impact, it is recommended that the additional information included within the TDM measure should focus on costs/benefits which can be allocated to the individuals which chose to use their private vehicle.

Information that illustrates the potential benefit, or detriment, that a change in travel behaviour holds for an individual may increase the likelihood of a collective behavioural shift. Monetary cost information, aimed at highlighting the monetary impacts of private vehicle utilisation relating to transport activities, may create enough of a perceived benefit to motivate individuals to alter their entrenched travel behaviour patterns. By illustrating the potential monetary savings available to individuals if they were to alter their travel behaviour, it may be possible to generate sufficient motivation to entice a change in travel behaviour.

Informing individuals of their environmental impact would focus on the long-term social costs of behavioural trends, whereas monetary cost information would monetise current travel patterns and thereby reflect the personal impact of travel in the short term. The benefits of incorporating both monetary and environmental impact information may therefore produce a more compelling TDM tool to overcome the reluctance associated with changing behaviour purely for the common good.

The successful implementation of such a measure would allow for the use of personal benefit, in the form of monetary savings, to also promote social gain by reducing transport-related externalities. Individuals would be able to reap the immediate cost-saving rewards of reduced private vehicle usage due to a better understanding of the monetary costs involved with private vehicle transport. Likewise, society as a whole would benefit due to the lower environmental cost and other externalities resulting from a decline in private vehicle utilisation.

1.3 SIGNIFICANCE OF THE STUDY

Of the three types of measures identified, informational and educational measures are significantly cheaper to implement and suffer no sunk costs usually associated with new transport infrastructure. These measures can also be implemented relatively quickly and seldom require significant public negotiation. Despite this, their impact has been shown to be less effective for various reasons. If a TDM measure focusing on sharing travel cost information is found to have successfully altered travel behaviour patterns, it would achieve this on a much smaller budget compared to other types of measures used for influencing transportation demand on networks. Additionally, it would mean that the largest contributors of negative transport externalities, i.e. private vehicle users, would be the ones reducing their vehicle usage and potentially large benefits may thus be realised. These benefits could include an overall better environment, less congestion on the roads, fewer road accidents, and increased disposable income for those who chose to reduce their private vehicle usage, among others. These two factors mean that, if successful, this measure has the potential to result in a much higher benefit-cost ratio than when compared to alternative TDM measures.

In national terms, if the study is found to be successful, it could potentially address capacity problems within transportation networks, thereby reducing the government's expenditure on expanding and maintaining transportation infrastructure. This money could then be utilised in other sectors, which may reap economic and social benefits. For individuals, the resulting increase in disposable income could potentially be used in sectors other than transportation, which would have the potential of boosting the local economy, which in turn could lead to further economic growth.

South Africa is a developing country that experiences rather significant private vehicle growth. It would be beneficial to create a culture where individuals are encouraged to utilise alternative modes of transport, or to better plan their travel by considering all the impacts. The experience from past voluntary TDM measures revealed a muted response to information sharing. This may be due to the presentation of benefits linked to altering travel behaviour not being sufficiently influential, the use of information that is perceived to be too generic, or other factors. By customising information and directly revealing personal monetary benefits, it is hoped that individuals will respond more positively.

Collectively, the benefits of individual responses may in fact induce significant aggregate changes in social behaviour patterns. This concept was illustrated in the recent public campaign to reduce water use in Cape Town (Cotterill, 2018). If this is found to be the case for travel behaviour as well, not only will the individuals benefit from this change in behaviour, but society as a whole as well.

1.4 RESEARCH FOCUS

1.4.1 Problem statement

Private vehicle users either do not take all the costs associated with private vehicle use into full consideration or they do not entirely understand how these costs are generated. As a result, individuals do not fully "internalise" their transport cost, which leads to a suboptimal decision-making process. This has both a personal impact, in the form of increased monetary expenditure, and an increased social impact, in the form of increased externalities.

1.4.2 Aim of the study

The focus of this research study is to investigate any alteration in travel behaviour that may occur due to participants being informed of various aspects regarding their travel patterns. Before information sharing can take place, an investigation into the potential for various types of information to be shared with participants will be made, with the final decision being to share actual monetary and environmental costs with participants.

This study requires that an information-sharing technique be developed and tested. This is done to assist in the measurement of the impact regarding information sharing and moral persuasion as a viable TDM technique aimed at reducing private vehicle usage, which would result in fewer transport externalities. The information utilised in the study focuses on personalised monetary and environmental costs, which were presented to the participants.

1.4.3 Research objectives

The research aim is refined in the following research objectives:

- Investigate whether actual monetary transport costs differ from the perceived costs of private vehicle commuters.
- Assess if it is possible to quantify environmental costs associated with private vehicle transport in a manner that is understandable to the average private vehicle user.
- Investigate the best method of obtaining all the necessary private and travel behaviour information needed in order to determine accurate monetary and environmental cost information.
- Identify whether an alteration in travel behaviour was realised as a result of the proposed TDM measure.

As a final step, a tentative inquiry into the relevant socio-demographics will be undertaken in order to assess the potential impact of information sharing on various population segments, by means of analysing data obtained from a Mobility Study. This will provide insight into whether TDM measures hold greater or reduced potential when attempting to influence travel behaviour patterns of various population subsets.

1.4.4 Research questions

The research questions of this study are as follows:

- What are the actual monetary transport costs incurred by private vehicle commuters?
- Do the road-use costs that individuals perceive differ from the actual road use costs incurred?
- What are the environmental costs of private vehicle usage?
- How can these environmental costs be quantified in an easily understandable way for the participants?
- How can individuals be informed of their actual monetary and environmental transportation costs?
- Is global positioning system (GPS) tracking a viable method to collect information for investigating current travel behaviour patterns?
- What is the impact of information sharing (i.e. monetary and environmental cost information) on the private vehicle users' travel behaviour?
- If a desired change in private travel behaviour was realised due to the availability of cost information, what potential benefits could this hold for the individuals and society as a whole?

1.5 STRUCTURE OF THE DISSERTATION

This dissertation has a total of six chapters. Chapter 1 covered the introduction, which identified the reason for this study, and presented the background of the study, the significance of the study, and the research focus, which included an overview of the problem statement, research aim, objectives, and questions. Chapter 1 concludes with an outline of the dissertation structure.

Chapter 2 provides a literature review of the subject at hand, and discusses transport externalities and motivations for private vehicle utilisation. The discussion then expands on various methods aimed at mitigating private vehicle usage. Research is conducted on previous related studies, as well as how travel behaviour choices are determined, and a case for developing countries such as South Africa is made. This chapter concludes with a summary of findings and a conceptual framework in an attempt to link the various concepts as discussed.

Chapter 3 discusses the methodology followed during the process of data collection. The methods utilised to create and collect data relating to various participant responses from the different questionnaires and GPS tracking process, as well as the limitations regarding the methods followed, are presented. Additionally, the case study timeline is briefly discussed, as well as the ethical clearance process and the approval that was required before data collection could commence.

Chapter 4 presents the research findings related to the identification of participants, which may be more likely to reduce private vehicle usage due to various motivating drivers. This section can be viewed as a precursor to the GPS tracking study proposed within this dissertation due to its aim being to identify what types of information are found to hold potential regarding driving participant willingness with regard to reducing overall private vehicle usage. The data used for this analysis were collected from a related research study performed in 2015 titled “The Stellenbosch University Mobility Study” (see Venter, Hitge, Krygsman & Thiart, 2018). This chapter discusses in detail the data collected and questionnaires utilised during this study. Furthermore, the methods of data cleaning and analysis are expanded on and the chapter concludes with a section on the results and a summary of the findings, where identified subsets of the population and their potential willingness to reduce private vehicle usage due to various motivating drivers are discussed.

Chapter 5 provides the analysis and findings relating to the GPS and questionnaire data collected by the methods outlined in Chapter 3. In this chapter, questionnaire responses and travel behaviour patterns are analysed and participants are segregated in terms of demographics and vehicle characteristics. This is done to assist in isolating any relationships these aspects may have relating to travel behaviour alterations. An analysis of the change of participant estimations and perceptions regarding costs and disutilities, before and after the research exercise, is also conducted. The chapter’s

penultimate section involves the analysis of travel behaviour over time as the participants were exposed to information regarding their travel patterns. Finally, the chapter concludes with a short summary of findings.

Chapter 6 concludes this dissertation with an overall summary of the findings regarding the research study. This chapter also outlines whether the aims, objectives, and research questions of the study had been achieved or answered. This chapter concludes with recommendations for future research regarding information sharing as a TDM technique.

CHAPTER 2:
LITERATURE REVIEW

2.1 INTRODUCTION

A selection of literature was reviewed in order to create a better understanding of the subject at hand. Firstly, the negative implications (also known as externalities) and the benefits associated with transportation and transportation networks are investigated.

Once the negative externalities have been identified, the motivation for why individuals choose to use private vehicles is discussed. This is followed by TDM measures and techniques that aim to reduce and mitigate private vehicle usage. The advantages and disadvantages of these techniques are identified, and a case for utilising information-based TDM is built.

Following this, qualitative research on previous studies which attempted to limit or mitigate the negative externalities by utilising information-based TDMs is conducted. This is done to build an understanding of the various methodologies used in these studies, in addition to assisting in the awareness of where the studies had been implemented and to reveal what the results of these measures were.

Next, in order to understand how individuals make their decisions regarding the utilisation of a transport mode for a specific trip, the aspects that influence their decision making are investigated. This leads to an investigation of their perceptions regarding transportation and the various challenges that may accompany an information-sharing TDM due to these perceptions' influence on the decision-making process.

Following this, a short summary of literature that discusses the unique characteristics of transport systems within developing countries is provided. This is followed by a brief outline of the current transport situation in South Africa, as well as a discussion of the reasons the potential implementation of TDM techniques may be beneficial.

The chapter concludes with a short summary of the overall findings, followed by a conceptual framework of how these various thoughts and insights interlink and relate to one another. This conceptual framework additionally assists as a summarised version of the general understanding used to further develop this study.

2.2 TRANSPORTATION EXTERNALITIES

Externalities are measurable costs associated with vehicle use that generally are not taken into account when using a vehicle. As they are rarely taken into account during the decision-making process, a suboptimal allocation of resources is often experienced, which can be regarded as a form of market failure. Road casualties, pollution, noise, congestion, social isolation, damage to wildlife and the countryside, and resource depletion are just some of the costs involved in transportation regarding environmental, social, and economic costs (Stradling, Meadows & Beatty, 2000). These negative externalities are also mentioned in Steg's (2005) study, where it was stated that the use of private vehicles appears to be the leading cause of issues that affect environmental air and noise quality, the quality of urban life, and the accessibility of certain areas due to roads, and sometimes large highways, that disconnect communities.

Private vehicles have a relatively poor load factor compared to other transport modes. The definition of load factor within transport terms is the capacity utilisation of a transport service and is usually quantified as passengers per vehicle (Wikipedia, 2017). Generally, it is believed that due to the relatively poor load factors of private vehicles, the combined externalities of these individuals using private cars are far greater than if these same individuals were to utilise an alternative mode of transportation. Thus, when taking load factors into consideration, it is widely understood that private vehicles appear to be the largest contributors of negative transport externalities.

Ellaway, MacIntyre, Hiscock and Kearns (2003) found that negative externalities are not the only externalities that originate from the use of private vehicles. The positive externalities experienced from private vehicle ownership and usage include a higher overall perceived level of mastery, self-esteem, and feelings of autonomy, protection, and prestige. Additional positive benefits of transport include increased accessibility of public goods, such as healthcare systems and education. This increase in accessibility is also often linked to increased land value. Transport also leads to the potential for increased city growth, which in turn allows for greater economic opportunities. Furthermore, supplementary benefits arise from the possibility of achieving greater efficiency within various industries, which would be absent if transportation did not exist (Rothengatter, 1994).

The presence of both positive and negative externalities leads to conflicting ideals. The use of private vehicles instead of other means of transport, such as cycling, walking, or public transport, has been shown to impact both car users and non-users. However, the negative impacts on others do not alone appear to reduce private vehicle usage. This may be due to the tendency for individuals to place stronger values on the benefits originating from private vehicle usage than on the negative social impacts associated with private vehicle usage. This behaviour could also potentially be due to the

vehicle users not being fully aware of their impacts on others or themselves, therefore this avenue is investigated further in the sections that follow.

2.3 MOTIVATIONS FOR PRIVATE VEHICLE USAGE AND TRAVEL DEMAND MANAGEMENT (TDM) TECHNIQUES

Now that an understanding of transport externalities has been established, before the methods devised to mitigate these externalities are discussed, it would be useful to understand the main motivations behind why individuals drive private vehicles in the first place. Gardner and Abraham (2007) found that journey time concerns, journey-based affect, effort minimisation, personal space concerns, and monetary costs are just some of the main motives that drive private vehicle usage. Overall, a commuter's desire to be in control was understood as being the main underlying factor regarding the motivation behind private vehicle utilisation.

It should be noted that individuals who mentioned monetary costs as being a motivating driver for private vehicle usage did not consider the full costs of private vehicle utilisation. Gardner and Abraham (2007) found that the costs associated with single car journeys tended to only include fuel costs and were therefore underestimated in general. This incorrect perception of costs can lead to undesired behavioural trends regarding private vehicle usage.

According to Steg (2005), people choose to drive their private vehicles because they love to do so. This in turn creates a positive utility in the eyes of the commuter and may be a cause of why some attempts at influencing car usage may not have been successful in the past. Steg (2005) further stated that if this statement were regarded as true, in order for individuals to be expected to leave their vehicles, or to drive less, the positive utility (the positive impact experienced by the individuals) of doing so must be higher than the positive utility experienced from continuing the use of their private vehicles without change. This is due to individuals rather wanting to be "pulled" out of their vehicles than "pushed".

Even though individuals may prefer to be "pulled" rather than "pushed" out of their vehicles, pushing measures have successfully been implemented in the past. The public acceptability of pushing measures tends to be generally low, because in order to push individuals out of private vehicles, a mechanism needs to be introduced that forcibly makes them less attractive (introducing additional costs is one way of doing this).

However, not all push mechanics deliver the same impacts. Albert and Mahalel (2006) discussed that individuals tended to be more willing to pay for an increase in parking than for a newly implemented congestion charge. This has to do with the demand elasticity regarding each situation. Albert and

Mahalel (2006) found that even though individuals dislike having to incur "out-of-pocket expenses", due to the respondents already being accustomed to paying for parking, these cost increases could more easily be absorbed. This caused the willingness to pay for parking charges to be much higher than for newly implemented congestion or road charges.

The inverse scenario would be to pull individuals out of their vehicles. This involves creating attractive incentives with the desire to instil a reduction in vehicle usage, or perhaps even a complete modal shift to other modes of transport. In order to elaborate further on the measures that can be used, several TDM measures are expanded upon below.

Various techniques have been developed in hopes of reducing the externalities associated with transportation. These measures utilise different approaches in order to achieve their overall goal of reduced negative transport externalities. These techniques can be broken down into three groups, namely physical change measures, legal policies, and informational or educational measures. Examples of these are presented below, followed by a thorough discussion of each.

- **Physical change measures:** Improving public transport, improving infrastructure for walking and cycling, park-and-ride schemes, land use planning to encourage shorter travel times, and making cars more energy efficient.
- **Legal policies:** Prohibiting vehicle traffic in city centres, parking control, decreasing speed limits, taxation of cars and fuel, road or congestion pricing, kilometre charging, and decreasing costs for public transport.
- **Informational and educational measures:** Individualised marketing, public information campaigns, giving feedback regarding the consequences of behaviour, and social modelling (Gärling & Schuitema, 2007).

2.3.1 Physical change measures

As mentioned earlier, transportation is associated with multiple externalities; one of which is congestion. Stopher (2004) made some relevant findings in his research on the utilisation of methods that aimed to reduce congestion. He found that congestion had been present for many years and that it was not possible to truly eliminate it. He stated that it is very desirable to improve public transportation systems with the intention of increasing ridership and therefore limiting the congestion caused by private vehicles. This measure can be classified as a form of physical change measure.

Stopher (2004) later stated that the sole use of this method was found not to be feasible, because the monetary investment needed would be extremely high. This level of capital investment, coupled with the sheer number of passengers that the system would need to accommodate, would produce levels

of demand that public transport would find very difficult to serve. In addition, Stopher (2004) noted that trends that illustrated that the market share of public transport usage was actually shrinking and that individuals began living farther away from their place of work further strengthened his belief that this method alone would not result in success.

2.3.2 Legal policy measures

Legal policy measures are usually utilised with the aim of altering behaviour by influencing decision making in one of two ways. The first method is to effectively punish individuals for their current behaviour in hopes of instilling a behavioural shift. The second method is to reward individuals for displaying desired behavioural traits. Various legal policy measures are disused below.

Stopher (2004) advised that governments and road operators should rather invest in legal policies that assist in the improved management of inevitable private vehicle usage. By doing so, they would need to accept that congestion may never be eliminated. Even though congestion shows the capacity of infrastructure being fully utilised, which in some industries is seen in a positive light, Stopher (2004) recommended that policies should rather focus on spreading peak travel times. This would assist in a better overall use of road space throughout the day.

Stopher (2004) investigated various "punishing" legal policy measures but was not fully convinced of their suitability as a TDM technique. He stated that some legal policy measures, such as congestion pricing, could also influence, and indeed reduce, the demand for transportation. Stopher (2004) also stated that a measure such as congestion pricing would only be effective in the short term, due to it delaying the inevitable build-up of congestion, which would lead to it becoming ineffective in the long term.

Another form of legal policy to limit the use of road vehicles did, however, gain Stopher's (2004) approval. Road pricing was investigated as it held potential as an effective pricing mechanism. This measure would directly charge users for the use of a road, based on distance, time of day, or duration fees, whereas congestion pricing is aimed at specific vehicle types and charges users according to these characteristics rather than the amount of road they used.

D'Acierno, Gallo and Montella (2006) discussed how the use of parking pricing plays an important role in balancing the modal split between private and public transport. In their research, the authors noted that parking pricing is one of the easier TDM techniques that could be implemented, given that it did not require any advanced technologies to be adopted in order to be successful. The aim of implementing an increased parking charge would ideally disincentivise individuals from using private

vehicles, as these would need to be parked once the desired destination is reached, thereby potentially increasing the usage of alternative transport modes.

Kelly and Clinch (2006) investigated the potential impact of parking pricing as a TDM technique in Dublin, Ireland. This research study found that as parking charges steadily increased, a gap regarding price sensitivity widened between business-trip and non-business-trip commuters. At lower levels of parking price increases, no discernible difference was found between business and non-business commuters. However, as the price steadily increased, it was found that the gap between the two subsets began to widen.

Business commuters were found to be less price sensitive to parking price increases than non-business commuters. This finding illustrates that increasing the price of parking influenced "choice" trips (non-business), whereas individuals who presumably had little choice in their destination, due to prescheduled business meetings, would inevitably absorb any cost increases incurred upon their travel.

This could be an important finding due to the deduction that business commuters are less sensitive to increases in transportation costs. This may lead to the results of some TDM techniques, which utilise increased transportation costs as a measure, having unsatisfactory results. Therefore, it should be noted that when planning the implementation of a new TDM technique, the types of commuters targeted must also be taken into consideration.

Although many believe that using transport pricing measures such as road, parking, and congestion pricing have potential to resolve problems caused by transport, there are a number of issues with implementing such measures. The problem where various income groups will have varying sensitivities toward a pricing measure is one such issue. Another issue has to do with the public's acceptance of transport pricing options. Schlag and Teubel (1997) researched the public acceptability of such transport pricing measures and noted that the public acceptability of pricing measures is in general quite low. Due to this, the operators who hold the power to implement these measures may fall under political or economic pressure from the public. This pressure may lead to measures that aim to increase the costs associated with transport to not be fully implemented as intended, or even perhaps to be totally abandoned.

As mentioned in the opening paragraph of this subsection, rather than penalising individuals for undesired behaviour, legal policy measures can also be utilised with the intention of creating incentives for desired behavioural trends. Hensher (2006) investigated methods that could reduce single-occupancy private vehicle usage by creating and increasing incentives for individuals and companies that alter their travel behaviour. In his research, Hensher (2006) mentioned how the United

Kingdom (UK) and the United States of America (USA) often place emphasis on single-occupancy vehicles and incentivise and encourage ride sharing. They also attempt to shift the private transport commuters out of their cars into public transport or other sustainable transport modes.

Governments can influence the number of single-occupancy private vehicles in multiple ways. One way is to incentivise ride sharing by introducing various organisations to, and assist them in formulating, carpooling schemes. Another way is to incentivise the installation of locker rooms with showers for cyclists. Governments also attempt to ensure that ride-sharing incentives are not lost in the long term by creating employer tax concessions. This is done to keep companies invested in these schemes.

On a closing note, Hensher (2006) cautioned that if governments plan to migrate their current private vehicle users to public transport, then the governments must ensure that the public transport networks have sufficient capacity to handle the shift in transport mode. If this is not the case, the congestion found on the roads due to private vehicles will just be transferred to the public transport network, which will cause bottlenecks at stations and will prevent the efficient operation of the public transport network.

Another potential issue when implementing TDM measures that alter the “costs” in order to achieve behavioural shifts, as legal policy measures tend to do, was uncovered by Cullinane (1992). Here it was found that measures that have a greater direct impact on the disposable income of individuals resulted in larger reductions of vehicle usage. Cullinane's (1992) statement is further supported by Mahmood, Bashar & Akhter (2009) who have stated that congestion pricing, which directly impact the disposable income of individuals by increasing costs associated with vehicle usage, is often used to discourage individuals from using their private vehicles during certain times of the day or within certain urban areas. These pricing measures, however, were also shown to touch on a problematic area. It was revealed that the implementation of these types of measures (higher parking costs and congestion charges) had a larger impact on lower-income groups than on higher-income groups.

This increased impact on lower-income groups is partly due to the costs taking up a larger proportion of the disposable income of lower-income individuals than when compared to higher-income individuals. Additionally, higher-income individuals who used private vehicles regularly were found to usually utilise company cars. Due to this, their transport costs were often shifted to their employers. These individuals were therefore less sensitive to changes in transport costs compared to lower-income individuals, as they did not bear the full brunt of increases in transport costs. The significance of understanding the target audience when planning to implement a TDM measure is therefore emphasised.

2.3.3 Informational and educational measures

Within the transport industry, informational and educational measures aim to change commuters' beliefs, attitudes, values, perceptions, understanding, and personal norms with the goal of reducing the use of private vehicles. Gärling and Schuitema (2007) stated that in order for a TDM to be effective, it must be able to:

- reduce the attractiveness of car use;
- activate car-use reduction goals; and
- reduce uncertainty and costs of achieving the activated car-use reduction goals.

It should be noted that, according to Gärling and Schuitema (2007:141), "[t]he underlying assumption is that people's travel choices depend on cost-benefit analyses of alternatives". Therefore, when undertaking a transport choice, it must be assumed that individuals undergo a rational decision-making process. If it can be shown that the assumptions individuals make toward private vehicles or public transport are incorrect, or if the individuals in question are simply uninformed, once informed with accurate information, behavioural changes should be experienced.

This, however, may not always be the case. Thøgersen (2006) stated that most transport modal choices tend to be repetitive and therefore habit forming. Due to this, he believed that when attempting to increase the attractiveness of alternatives to private vehicle transport, informational and promotional means could be used; however, these messages would need to be strong enough to break the habitual trend.

In order to ensure true transport behavioural change, if it is assumed that individuals undergo a rational decision-making process when deciding on their mode of transport (Gärling & Schuitema, 2007), the presentation of new information may have the ability to influence their decisions. However, due to the repetitive and habitual nature of transport behaviour (Thøgersen, 2006), any information presented must be strong enough, influential and long-lasting to cause the individual to adjust their habitual trend of transport and to ensure the trend remains broken.

Thøgersen (2006:634) stated that the public transport network on offer is not a particularly attractive alternative as "structural conditions need to be changed to increase the attractiveness of public transport, or reduce the attractiveness of car transport". Although altering structural conditions could be interpreted as a physical measure, and reducing the attractiveness of private vehicles could be achieved by implementing a legal policy measure, the shift in the "perceived" attractiveness of structural conditions and private vehicles can both be achieved by utilising informational measures.

Due to the capital-intensive nature of physical measures and the low public acceptability of pricing measures, these measures may not be the ideal choice for all situations. If informative measures could show individuals that their biased assumptions of private vehicles were incorrect, while simultaneously improving the public's perception of structural conditions, then it would be feasible to use informational and educational measures as a means to reduce the overall usage of private vehicles within the transport network.

According to Bamberg, Fujii, Friman and Gärling (2011), another type of informational measure that holds much value in reducing private vehicle usage is Personalised Travel Plans (PTPs). They stated that due to pollution caused by private vehicles, if vehicle usage was not reduced, the environment's future would be under threat. Bamberg *et al*. (2011) suggested the use of transport policy measures that integrate some type of informative intervention that would attempt to reduce the use of private vehicles.

PTPs are tailored programmes that optimise travel routes for individuals in order to minimise the overall distance that is driven. These programmes benefit the participating individuals by reducing the time and money spent travelling, while also benefiting others by reducing the externalities caused by vehicle usage. It was concluded that although promising, further development of cost-effective PTPs is still needed in order to aid in the reduction of private vehicle usage (Bamberg *et al*., 2011).

In the UK, where the factors affecting demand for public transportation were investigated by Paulley *et al.* (2006), it was shown that as long as population size remains mostly constant, traffic growth would be derived from two sources. The first source is additional trips that individuals choose to undertake, and the second source could be the longer trips individuals choose to undertake. This emphasises the theory that in order to reduce congestion and other transportation problems, one must aim to either lessen the number of trips taken or shorten the distances travelled. Both these goals can be achieved by means of implementing a successful PTP.

A PTP, coupled with educating individuals on the impact of their travel behaviour on the environment, may hold potential for further reducing vehicle usage. When testing the factors that influenced the willingness to reduce personal vehicle usage of individuals, Nordlund and Garvill (2003) emphasised that the negative environmental consequences of private vehicle use should be explained to individuals as there is a growing trend for individuals to be more environmentally aware of their actions. This growing trend translates into a willingness to reduce their impact on the environment, and if individuals feel that this can be achieved through limiting their use of private vehicles, they may be motivated enough to do so.

2.4 PREVIOUSLY RELATED STUDIES

This section reviews some previous studies that attempted to alter travel behaviour by utilising informational/educational TDM measures. The main information extracted from these studies refer, where possible, to who conducted the study, when it was conducted, where it took place, how many participants were involved, the length of the research period, what information the participants were presented with, how potential changes in behaviour were monitored, and the results of the research. Many research studies were reviewed, with some of these having been discussed in previous sections, therefore a short summary concerning what are believed to be the six most relevant research studies are presented next. These have additionally been split into two categories, namely the review of informational TDM techniques and the case for technology incorporation.

2.4.1 Review of informational/educational TDM measures

Tertoolen, Van Kreveld and Verstraten (1998) attempted to investigate the behavioural effect of information on car use in the Netherlands. Three hundred and fifty subjects were tested in the research, where they received feedback concerning the environmental and financial costs associated with their car use. This study found that, whether given feedback or not, there was no discernible change in the travel behaviour among the monitored individuals. Tertoolen *et al*. (1998) argued that the measures used to inform individuals of their incurred environmental and financial costs proved insufficient to induce change because these commuters strongly linked positive attitudes to various advantages of car use. These advantages heavily outweighed the disadvantages of car use in the views of the monitored subjects. Because this study was conducted nearly two decades ago, if the same experiment were to be undertaken today, a discernible change in travel behaviour may potentially be observed due to changes in attitudes and values that individuals have toward to the environment and monetary incentives compared to individuals in the 1990s.

Cairns, Newson and Davis (2010) attempted to further understand the factors that contribute to successful travel initiatives within workplace across the UK. The study reported on 20 case studies regarding the implementation of travel planning programmes on employers within the UK. It was concluded that substantial alterations in private vehicle usage can be achieved by the utilisation of information sharing and, in some cases, incentive-based travel planning programmes, although it was stressed that each of these programmes should be tailored to the employer targeted and unfortunately no “one-size-fits-all” approach is therefore applicable. After reviewing the case studies, it was found that, on average, commuter driving had been reduced by an average of 18%.

In Adelaide, Australia, Rose and Ampt (2001) developed a new approach to individual travel behaviour modification and named the programme "Travel Blending". The process involved participants being issued with multiple "kits", which were aimed at providing information while assisting in the collection of data by means of a travel diary. The travel diary data were analysed and a new "kit" was sent to the participants, which included tailored information on how they could alter their travel patterns. After a certain period had elapsed, another travel diary was completed, and the process would repeat again. The main study took nine weeks to complete and included 100 households. The results indicated a 10% reduction in private vehicle usage after the nine-week period. Rose and Ampt (2001) concluded that while the results appeared to be encouraging, one should remain cautious when interpreting them and that further research would be required before any definitive findings could be attained.

2.4.2 The case for incorporating technology into TDM measures

In order to identify if there is room for technology to assist in TDM measures, further research into whether technology is found to be beneficial or a hindrance regarding TDMs was conducted. "Quantified traveler: Travel feedback meets the cloud to change behavior" was a study that investigated technology's potential to assist in TDM measures. Undertaken by Jariyasunant *et al.* (2015), the researchers attempted to computerise a travel feedback programme with the aim of developing a system that would allow for greater efficiency while simultaneously reducing the costs associated with programmes of this nature. It was stated that the costs and availability of counsellors, who would usually guide participants into making better travel choices, resulted in complications in the programmes. Their proposed solution was to create a computational travel feedback system that would include data visualisation and monetary and environmental cost calculators, as well as utilise algorithms to assist in the personalisation of travel programmes. This system would then be uploaded to a cloud and would allow participants to use it as frequently as they wished. Once developed, the research study took place in San Francisco, USA, over a three-week period and included a total of 135 participants. The results were positive, illustrating an average reduction of 33% in vehicle kilometres travelled. This study therefore demonstrated that the use of technology may in fact be beneficial to creating successful TDM measures.

UBIGreen is a mobile phone application created with the aim of altering transportation behaviour by utilising imagery and additional environmental information (Froehlich *et al.*, 2009). Once the mobile application had been developed (which required a series of online surveys and feedback from potential participants) and was ready for testing, the real-world study took place over a three-week period and the travel behaviour patterns of 13 individuals were measured to determine whether there

was any impact. The application illustrated the impacts that participants' travel behaviour had on the environment by utilising images with the aim of visually stimulating individuals to reduce transport behaviour that may be harmful to the environment. The results of the study demonstrated that certain behavioural trends appeared to shift toward more environmental friendly patterns; however, (Froehlich *et al.*, 2009) concluded that not enough evidence was available to achieve a definitive finding.

Stopher, Clifford, Swann and Zhang (2009) investigated the potential of utilising GPS devices in order to assist in the measuring and accuracy of tracking of participants' travel behaviour patterns. The paper reviewed three case studies in Australia and evaluated the approaches, as well as suggested guidelines regarding these studies. It was advised that when dealing with large sample sizes, the measurement of change should be the main focus point in analysis. Here it was concluded that, ordinarily, paper-based travel diaries have multiple issues associated with them, such as errors in self-reporting measurement procedures. In order to deal with this issue, it was proposed that, where possible, GPS devices should be used. These had been shown to be superior to simply collecting odometer readings while simultaneously removing any self-reporting error that may be present when participants are expected to complete a travel diary.

Overall, from the review of these previous studies, it can be deduced that modestly positive results regarding the sharing of information in an attempt to induce desired changes in travel behaviour appear to be achievable. Additionally, the incorporation of technology appears to mitigate some of the challenges in terms of the collection of travel behaviour pattern data, and in some cases it has been shown to improve the overall efficiency of TDM measures. Finally, it has been advised that, where possible, that GPS technology should be included due to its ability to assist in data collection while reducing the potential for errors.

In contrast to the studies discussed above, this research attempted to test the application of an information-sharing TDM measure in a developing country. Therefore, many unknowns are applicable to this study and the successful implementation of a newly developed TDM measure is all but guaranteed. Aiming to make individuals aware of their unknown costs may potentially induce the desired self-regulatory behavioural change. However, due to the lack of suitable alternatives or substitutes to private transport, this increased awareness may not have any impact on travel behaviour. Therefore, before any further steps regarding the development of this TDM measure are taken, it is suggested that an investigation must first be conducted on how individuals make their choices regarding travel behaviour. Finally, it is also suggested that research on the potential challenges and opportunities, regarding the implementation of a TDM measure within South Africa, should also be conducted.

2.5 HOW TRAVEL BEHAVIOUR CHOICES ARE MADE

In order to understand how individuals choose their regular mode of transport, one must first understand that transport as an activity is a by-product. This by-product is the result of individuals desiring to be located to their end destination. Therefore, it is often stated that the demand for transport is a derived demand. Due to transport only being "a means to an end", it is generally acknowledged as an activity that holds negative attributes (often referred to as sacrifices) and costs associated with it.

Given that it was stated earlier that it should be assumed that commuters' travel choices depend on cost-benefit analyses and they are therefore rational decision makers (Gärling & Schuitema, 2007), it should be fairly straightforward to determine which mode of transport individuals will use. By determining the travel time and monetary costs associated with a mode of transport, usually called the economic costs, determining the mode used for travel should entail selecting the mode with the lowest combined total economic cost.

However, as identified by Pienaar (1997), individuals do not always choose the transport mode with the lowest economical cost available to them. Instead, there are additional factors that must be taken into account to understand how individuals choose their preferred transport mode. Given that transport is a derived demand and therefore has accompanying sacrifices, these sacrifices must be accounted for. Pienaar (1997) labelled the sum total of these sacrifices as the generalised costs associated with transport. The components of generalised costs, which together act as the "total disutility" associated with transport, are the monetary cost, travel time, and "other negative attributes".

Additionally, it should be noted that even though monetary cost and travel time can be calculated rather accurately, individual perceptions and values still play a significant role in determining the importance of these costs. Janicki (2015) found that individuals perceive their monetary costs associated with private vehicle transport to be less than the actual cost incurred. Due to this incorrect perception, when individuals attempt to mentally calculate the generalised cost associated with a transport mode, their final decision may be incorrect as they were in essence "misinformed".

In order to better understand the way commuters perceive their private vehicle costs, Adiv (1982) utilised two cost-estimation methods to calculate and investigate how individuals compute their transport costs. He then compared these values to the actual transport costs incurred and discovered a contradiction. One method of cost calculation found a perceived overestimation of vehicle costs, whereas the second method found a perceived underestimation of costs.

These findings were later resolved as more research established that the second method utilised to estimate costs was much more reliable than the first. Therefore, Adiv (1982) confidently concluded that individuals tend to underestimate the actual costs associated with transport. This finding once again reinforces the fact that when attempting to determine their ideal mode of transport, individuals may be doing so with incorrect information.

Further research on the actual and perceived running costs associated with private transport was conducted by Malecki (1978). He described the perception of commuters as an important determinant to their modal split characteristics due to decisions usually being made based on perceptions and not always on the true value of attributes.

Malecki (1978) concluded that, in general, the average perceived running costs regarding a vehicle were much higher than the average actual running costs incurred. This may come as a surprise, especially given that it was previously mentioned that individuals tend to underestimate their costs of transport. However, this discrepancy was explained in an article by Borg (1982), who argued that individuals very incompletely perceive their costs associated with vehicles. Borg (1982) stated that certain items relating to the cost of owning and running a vehicle are sometimes not acknowledged at all.

Therefore, it stands to reason that if individuals do not take into account some of their fixed costs (which tends to be the case), their total vehicle operating costs may be underestimated, even if their running costs were overestimated. This is believed to have been the case regarding Malecki's (1978) research, as mentioned above.

A study conducted by Cullinane and Cullinane (2003) in Hong Kong found that once people acquire a private vehicle, their perception leads them to believe that the vehicle must become a necessary part of their lifestyle. When an investigation into why people generally buy cars in a city such as Hong Kong, which possesses a relatively good public transport network, the authors stated that the initial reasons having to do with the purchase were due to individuals unlocking the ability to carry or transport more items between destinations. Another potential reason was due to perceived transport time savings. These vehicle purchases then led to a lifestyle shift where the use of private vehicles was believed to become the norm. Later it was concluded that a good public transport system is still capable of deterring private vehicle ownership, and this is believed to be the reasoning behind a relatively small share of private vehicles within Hong Kong's transport market (Cullinane & Cullinane, 2003).

Beirão and Sarsfield Cabral (2007) attempted to understand people's attitudes towards public and private transport with the aim of developing new measures to attract potential users to public

transport. It was found that the levels of service delivered by public transport must at the minimum be on par with the levels that customers require. This was discovered as during their investigation Beirão and Sarsfield Cabral (2007) found that if a service was identified to be uncomfortable, unreliable, and not in possession of a high rate of frequency, then individuals would likely rather utilise private transport rather than public transport. In the closing statements of their research, Beirão and Sarsfield Cabral (2007) declared that, in general, private vehicle users held lower perceptions of public transport than those who regularly used the service. The authors' concluding statement argued that one method that could be used to alter individuals' choice of transport mode would be to improve the image of public transport while simultaneously providing more information about the transport system's availability to population segments that were identified as having a higher transport mode switching potential.

The total utility, or minimisation of perceived total "disutility", is not the only driving force found to be associated with the decision-making process of individuals when selecting to use private transport or public transport. Their perception of self-image also influences their decision making. Johansson-Stenman and Martinsson (2006) found that individuals tend to be less concerned about the environment and more concerned about self-image than most would even admit to themselves. It is therefore crucial to understand that even though certain choices would make logical sense, such as using a private vehicle less to decrease expenditure on transport and to reduce the carbon footprint associated with that mode of transport, it has been found that individuals would sometimes consider the "cost" of improving their self-image and therefore become biased toward an otherwise suboptimal decision.

Before moving to the next section, to summarise the work covered above, it has been stated that individuals are believed to be rational decision makers when deciding between transport modes. These decisions are influenced by the generalised cost incurred by the transport mode, which includes monetary cost, travel time, and other disutilities associated with the mode. This decision-making process becomes more complex as the costs perceived may not always reflect the true cost incurred by the individual.

The overall goal should therefore be to inform individuals what the true costs of using private vehicles are in order to shift their perceptions to become more accurate. If the multiple research studies mentioned above are correct, and monetary costs are usually underestimated by individuals, the increased accuracy regarding cost estimations should increase the generalised costs associated with private vehicle transport usage. These increased generalised costs would in turn influence the individual's decision making by producing a less attractive view regarding private vehicle utilisation. Ideally, this would result in lowering the overall usage of private vehicles by (1) decreasing the total

number of trips individuals would take with private vehicles, (2) assisting in making individuals take shorter journeys by planning ahead of time to reduce the vehicle kilometres driven, or (3) inducing a modal shift away from private vehicles toward other modes of transport.

Figure 2.1 was sourced from research underpinning the internal factors that influence the decision-making process (Kitamura, Yoshii & Yamamoto, 2009). The figure illustrates that an individual's values influence their attitudes toward certain options, which in turn impact their final choice or behaviour, while all other aspects remain the same. Similarly, beliefs have been found to directly influence individuals' choices or behavioural patterns. Thus, if an individual believes in something that is not accurate, for example not having an accurate estimation regarding private vehicle costs, a shift in belief, by perhaps demonstrating that their perceptions may be incorrect, should instil an observable change in choice or behaviour. The final influencers in choice and behaviour are believed to be situational constraints and cognitive skills. Regarding situational constraints, in some situations individuals may find themselves in a position that prevents them from behaving in a certain way; even if they desire to behave differently, this is registered as an external pressure. Cognitive skills may also influence decision making as they define the core skills used to think, read, learn, remember, reason, and pay attention. Together, these skills allow individuals to take in information and apply any "lessons learned". Depending on the level of cognitive skills individuals have, and new information presented to the individuals, behaviours could be seen to change rather rapidly, or potentially not at all.

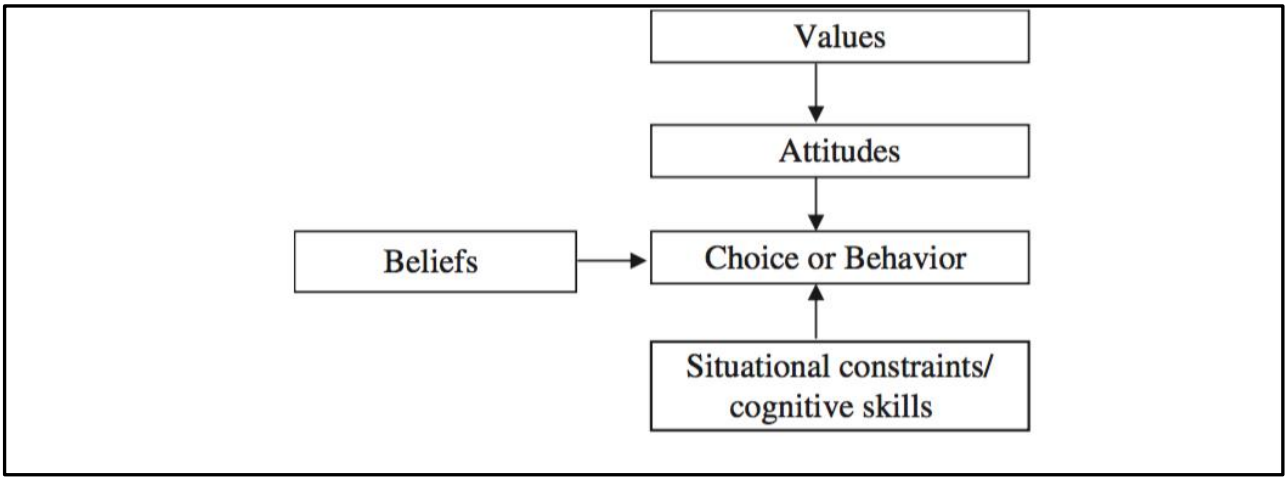

Figure 2.1: Illustration of how choice or behaviour is related to beliefs, attitudes, and values

Source: Kitamura *et al*. (2009:100)

Figure 2.2 illustrates the various methods believed to be available when attempting to modify travel behaviour. The three methods identified are money, power, and words.

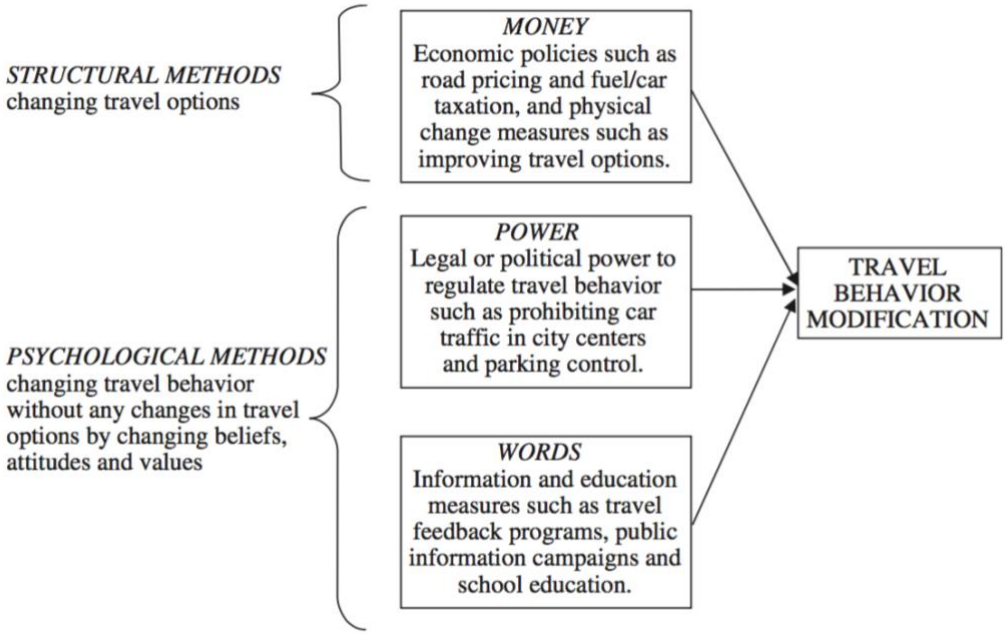

Figure 2.2: The ingredients in structural and psychological methods of travel behaviour modification

Source: Kitamura *et al.* (2009:106)

Money refers to structural methods such as economic road pricing policies and other physical change measures that can be used to influence travel behaviour. Power refers to regulators' power over aspects of transportation and includes examples such as traffic and parking restrictions. Words have been identified as informational or educational measures aimed at altering behaviour by providing information or educating individuals about certain aspects regarding transport.

In Figure 2.2, money is identified as a structural method utilised to alter the current structure of the transport network in order to make undesirable behaviour patterns less desirable, thereby creating situational constraints. Power and words, on the other hand, have been identified as psychological methods that aim to alter behaviour by changing individuals' beliefs, attitudes, and values.

Even though there are some differences regarding the exact structure and strict definitions of the figures illustrated above and the various techniques that can be used to change behavioural patterns within transport, as discussed in Section 2.2, the similarities regarding the use of words to alter travel behaviour and the informational and educational techniques discussed earlier remain quite substantial. This ensures that information can indeed be used as a TDM measure and should be used to influence individuals' values, attitudes, and beliefs to create a change in behavioural patterns.

2.6 A CASE FOR DEVELOPING COUNTRIES AND SOUTH AFRICA

Most of the research studies reviewed were conducted in developed countries. Developing countries experience a significant difference in political and economic climates when compared to developed countries. Different experiences instil different values and beliefs in individuals, and these aspects may additionally impact assumptions made regarding modes of transportation. Due to this study taking place in a developing country (South Africa), an investigation into the viability and suitability of transport-orientated measures is made below.

In a study that investigated public transport in developing countries, Sohail, Maunder and Cavill (2006) found that the role of transport regulators is crucial when attempting to improve or further develop the efficiency of transport networks. Furthermore, they stated that when attempting to create a sustainable public transport system, regulation must firstly be open, honest, and effective. Secondly, all relevant stakeholders should be consulted as this point is found to be critical if any form of regulation is to be effective. This includes passengers, employees, and owners.

The findings from Sohail *et al.*'s (2006) research paper underpinned the importance of regulatory bodies within developing countries, and that if effective transportation systems within developing countries are desired, regulatory outlines must be well structured and communicated for the benefit of all stakeholders.

Taking the above passage into consideration, it appears that the ability to understand the current regulatory situation plays an important role in determining whether a new measure can be defined as feasible. Therefore, prior to the development of a TDM measure, an investigation must be made into South Africa's regulatory climate. This is to ensure that the TDM would align itself with the desires of the government, and not be hampered by constraints present in current regulations.

Walters (2008) found that transport policies in South Africa focus heavily on improving and expanding the public transport sector within the country. The initial process of improving the transport network was believed to require a period of around 10 to 15 years (stated in 2008) and a continuation of minor improvements would develop after this. It therefore appears that the South African government is indeed focused on improving accessibility via improvements in the transport sector. This improvement would reduce and in some cases even remove barriers to public transport usage. Given that the proposed TDM of this study aims to reduce private vehicle usage, the availability of public transport as a potential transport mode alternative assists in the potential impact that the TDM may have. This assurance of whether individuals wished to switch transport modes and therefore utilise public transport as their main or supplementary mode further strengthens the potential of a TDM aimed at reducing private vehicle usage.

Additional goals outlined in the National Transport Policy White Paper of South Africa (Government of South Africa, 2015) include the following:

- "To improve the safety, security, reliability, quality, and speed of transporting goods and people";
- "To invest in infrastructure or transport systems in ways which satisfy social, economic, or strategic investment criteria"; and
- "To achieve the above objectives in a manner which is economically and environmentally sustainable, and minimises negative side effects".

To further emphasise the goals outlined by the South African government, the National Land Transport Act of 2009 presents the following statements:

- The South African transport industry accounts for 10.5% of total carbon dioxide (CO_2) emissions.
- The Department of Transport Strategic Plan 2013/2014 (revised) stated that the transport industry is not meeting its target of reducing carbon emissions by 10% per annum.
- Guidelines were also presented indicating that any new transport-related strategy should aim to move towards a low-carbon economy. This guideline was added due to South Africa committing to the United Nations Framework Convention on Climate Change (UNFCCC), which aims to reduce greenhouse gases by 34% by 2020.

In South Africa, the transport sector is the second largest contributor (after the energy sector) of carbon emissions. Actions to reduce the transport-related carbon emissions profile also support urban development needs, namely promoting public transport over private car use, decongesting roads through travel demand measures, shifting a greater proportion of freight onto rail, better spatial planning to limit urban sprawl, and investing in sustainable modes of transport such as non-motorised transport (paraphrased from the National Land Transport Strategic Framework, Department of Transport: Republic of South Africa, 2015).

By reviewing these goals stipulated by the National Transport Policy White Paper and the National Land Transport Act, it can be assumed that one of the objectives is to mitigate negative externalities relating to transport. These goals should be considered when attempting to develop and implement a new TDM technique. The fact that the proposed TDM measure in this research paper aims to reduce private vehicle usage, which in turn would reduce transport externalities, appears to indicate that the proposed TDM is a good fit.

When dealing with developing countries such as South Africa, factors other than regulation must be considered. Such factors have been stated in research by Mokonyama and Venter (2007), who found that in South Africa, car sales for private use have increased and are furthermore forecast to continue to increase drastically.

Mokonyama and Venter (2007) investigated whether running costs influenced individuals' buying decisions regarding private vehicles. When researching the influence of the fuel price on vehicle sales, their research indicated that the relationship remained rather inelastic. It was found that even when fuel prices increased with an average of 32% between 2000 and 2004 within the Gauteng province, the relationship between vehicle sales and even the engine sizes of these vehicles (which usually contribute to fuel consumption) remained largely unchanged.

It was suggested, however, that this inelastic relationship may change in the future, as individuals will become increasingly aware of the running costs that contribute to vehicle utilisation. Mokonyama and Venter (2007) expected the price of fuel to continue to rise within South Africa; due to this they believed that the increased costs may potentially lead to consumers becoming more price sensitive in the long run, thereby decreasing the demand for private vehicles and increasing the search for more affordable alternatives.

A possible reason behind the continued growth of vehicle sales in South Africa, even when fuel prices have increased, may be premature congestion, which is an issue many developing countries must acknowledge and address. Premature congestion is caused by the rapid growth of the population in a country. This growth is mainly experienced in cities and is caused by accelerating birth rates and uncontrolled immigration. This leads to the population of cities growing faster than the transport infrastructure that is meant to support the city.

Building on this, the number of private vehicles on the roads grows at an even quicker rate than that of the population. It has been stated that a vehicle-ownership growth rate of 15-20% per year in developing countries can be considered common (Gwilliam, 2003). This rapid growth of vehicle ownership, along with a transport infrastructure that cannot expand and keep up with the growth rate, leads to congestion and can ultimately result in the failure of the transportation system.

It could follow that if a TDM measure were implemented, and this measure increased and developed a self-regulatory culture in terms of private vehicle usage, then perhaps some current and future transport problems relating to South Africa may be avoided. By implementing an informational- and educational-focused TDM measure, individuals would become aware of the issues of transportation systems and could regulate themselves; thereby causing their travel behaviour patterns to change to

not only benefit themselves, in terms of incurring less expenditure on transport, but to assist in societal benefits as well.

To investigate whether South Africa experiences similar levels and types of externalities caused by road transport in developed countries and therefore understand whether measures used in these countries can assist in further technique development, Thambiran and Diab (2011) researched the various externalities caused by road transport in Durban, South Africa. Their research found that just as in developed countries, in order to sufficiently reduce externalities caused by transportation, limiting the kilometres driven by private vehicles and improving the efficiency of various other transport sectors would hold the greatest potential in South Africa. From this finding it can be established that even though South Africa is not a fully developed country, the same issues in the transportation sector impact it in terms of externalities, and solutions created in developed nations should be just as successful.

Many of the externalities mentioned above relate to the social and environmental impacts of transport on individuals in developing countries; however, the costs incurred by transport are not limited to social and environmental costs. Monetary sacrifices, as mentioned by (Pienaar, 1997), also accumulate with private vehicle utilisation.

According to the National Household Travel Survey of 2013 (Statistics South Africa, 2014), the average vehicle owner/driver spends more than R1 000 on their private vehicle per month. It should be noted that this cost is a perceived estimation and therefore it is very likely that it is underestimated. In addition, of the individuals who earn R6 000 or more per month, 82% own one or more private vehicle. Further research undertaken by Stats SA (Statistics South Africa, 2013), found that transport is the second largest expense experienced by the average household. The average household cost of transport, equated to 17.1% of the households' disposable income, was exceeded only by housing costs at 32% (these costs include housing, water, electricity, gas, and other fuels).

It can therefore be assumed that if a TDM measure were to reduce the usage of private vehicles, two potential benefits would be observed. The social and environmental externalities would be reduced, and a social benefit would thus be gained; however, the individuals who reduce their vehicle usage would receive the added private benefit of monetary savings associated with either travelling less or switching to a cheaper transport mode.

It is important to iterate that developing countries are not the only ones that face transportation issues. They should therefore attempt to learn from developed countries so that the development and implementation of various transport-related techniques and measures, which are found to hold potential, can be utilised.

Developed countries such as the UK and the USA have also placed emphasis on attempting to minimise the market share of private vehicles on public roads. Rather than implementing regulatory policies, these countries focused their efforts on minimising single-occupant car trips by creating incentives to encourage ride sharing per vehicle, with some success (Hensher, 2006). This could be a good focal point for TDM measures in South Africa.

If a TDM measure were to inform individuals of the true, actual costs involved when using a private vehicle, individuals may possibly investigate options that reduce those costs, whether it be by ride sharing, mode switching, or simply driving fewer kilometres, the incurred monetary savings would in essence become their own created incentive for altering their behaviour.

2.7 SUMMARY

It was found that transportation has multiple associated negative externalities. It was also found that the demand for transport is derived from the desire to take part in an activity at a destination other than an individual's current location, therefore transport is in essence a "means to an end".

Private vehicle transport is generally seen as one of the main drivers of these externalities. This is due in part to low occupancy within private vehicles, which contributes to a larger number of externalities being created per trip than if an alternative transport mode was utilised. However, it was also established that negative externalities are not the only externalities created by private vehicle transport. Individuals experience positive utility from using a private vehicle, which in turn leads them to favour the use of this mode despite the negative externalities associated with it.

The effect of perceptions regarding transport mode usage was also discussed. Individuals develop a bias toward private vehicles, not only because of the positive utility they gain from using it, but also because these individuals tend to not fully understand or simply are not concerned about how monetary costs associated with the mode are calculated. This leads to an overall underestimation of private vehicle costs. Given that it is assumed that individuals are rational decision makers and perform a basic benefit-cost calculation when determining the optimum mode of transport for a specific trip, this underestimation of costs sways individuals to theoretically utilise private vehicles more than in the case that they had accurate perceptions of costs. This is due to the incorrectly perceived estimation of costs that create an even greater distortion regarding the benefits (positive utility) compared to the costs (individuals and social) of using the mode.

Various TDMs were investigated, ranging from physical change, legal policy, to informational/educational measures. Here it was found that all three types of measures have potential to reduce the externalities associated with transport; however, each measure has its own

disadvantages when attempting to do so. Physical change measures do not inherently solve the cause of these externalities and therefore only delay the inevitable outcomes. They are also very capital and resource intensive, in addition to taking a long time to implement. Legal policy measures vary from simplistic measures of charging individuals for the time they park their vehicles in a demarcated area, to creating schemes that attempt to incentivise desired behavioural travel patterns. However, most of these legal policy measures include some form of "out-of-pocket" charge or pricing; these measures are not always publicly accepted and therefore result in difficulties when attempting to implement them. Informational and educational measures, when aimed at private vehicle usage reduction, assist in "pulling" individuals out of their cars by informing them of the facts behind private vehicle usage and thereby reducing the attractiveness of the mode. The overall goal of informational and educational measures is to encourage individuals to either reduce private vehicle usage or switch to a different mode altogether; however, in the past these measures have been shown to have limited impacts on actual changes in travel behaviour.

Concerning previous related studies, the outcomes did not look promising as studies that attempted to use informed costs measures with the aim of reducing private vehicle usage did not do so successfully. This could be due to several factors; one such factor, as stated earlier in the literature review, may have to do with travel behaviour being regarded as repetitive and therefore habit forming, with the implication that these habitual behaviours possess characteristics that are challenging to alter. Another factor may have to do with the fact that many of the studies were conducted in developed countries. The individuals who reside in these countries and utilise private vehicles may do so for reasons not applicable to developing nations. As this study is conducted in South Africa, which is regarded as a developing nation, the implementation thereof may potentially reveal findings regarding developing countries and uncover additional variables, which may be applicable to developing nations but not to fully developed ones.

Finally, many of the reviewed studies shared information by means of a PTP, which presented additional travel options to participants. This in turn created increased awareness of the existing available alternatives. However, this measure would not directly influence the overall decision-making process that individuals undergo when choosing their preferred mode of transport. When investigating how decisions are made regarding transport, the literature review established that individuals are assumed to be rational decision makers and choose their transport mode by means of a benefit-cost calculation. As previously suggested, individuals usually underestimate the costs associated with private vehicle usage, and if a measure were utilised with the aim of increasing their accuracy in vehicle cost estimation, a change in their decision-making process may be observed. If this was found to be the case, the measure may be successful in reducing overall private vehicle

utilisation by either reducing the number of trips or kilometres driven or by assisting in the overall shift from private vehicles to alternative transport modes.

2.8 CONCEPTUAL FRAMEWORK

Now that a good understanding of the topic and the additional factors that contribute to the subject has been developed, a conceptual framework can be established, which will assist in the development and implementation of the research exercises while simultaneously functioning as a reference point of how various aspects link to one another. The main concept behind this research study is to attempt to alter the travel behaviour patterns of individuals who utilise private vehicles by sharing information with these individuals. As previously mentioned, it can be assumed that individuals make rational decisions based on a benefit-cost calculation. It can also be assumed that, on average, individuals underestimate the costs associated with private vehicle utilisation.

The overall goal should therefore be to inform individuals of the true costs incurred when using private vehicles. The aim of this is to shift their perceived costs of private vehicle usage to become more aligned with the actual costs incurred. If the multiple research studies mentioned above are correct, seeing as monetary costs are usually underestimated by individuals, this increased accuracy regarding cost estimations should increase the generalised costs associated with private vehicle transport (Pienaar, 1996), thereby increasing its disutility.

These increased generalised costs (disutilities) would in turn influence the decision-making process of the individual by producing a less attractive view of private vehicle utilisation. This less attractive view would impact the internal aspects of decision making, such as the beliefs and attitudes that the individual associates with the mode (Kitamura *et al.*, 2009). Ideally, this would result in lowering the overall usage of private vehicles by (1) lowering the total number of trips individuals would take with private vehicles, (2) causing individuals to take shorter journeys by planning ahead of time to reduce vehicle kilometres driven, or (3) inducing a modal shift away from private vehicles toward other modes of transport. Figure 2.3 shows how the various aspects regarding travel behaviour link to one another, with an explanation of the connections to follow.

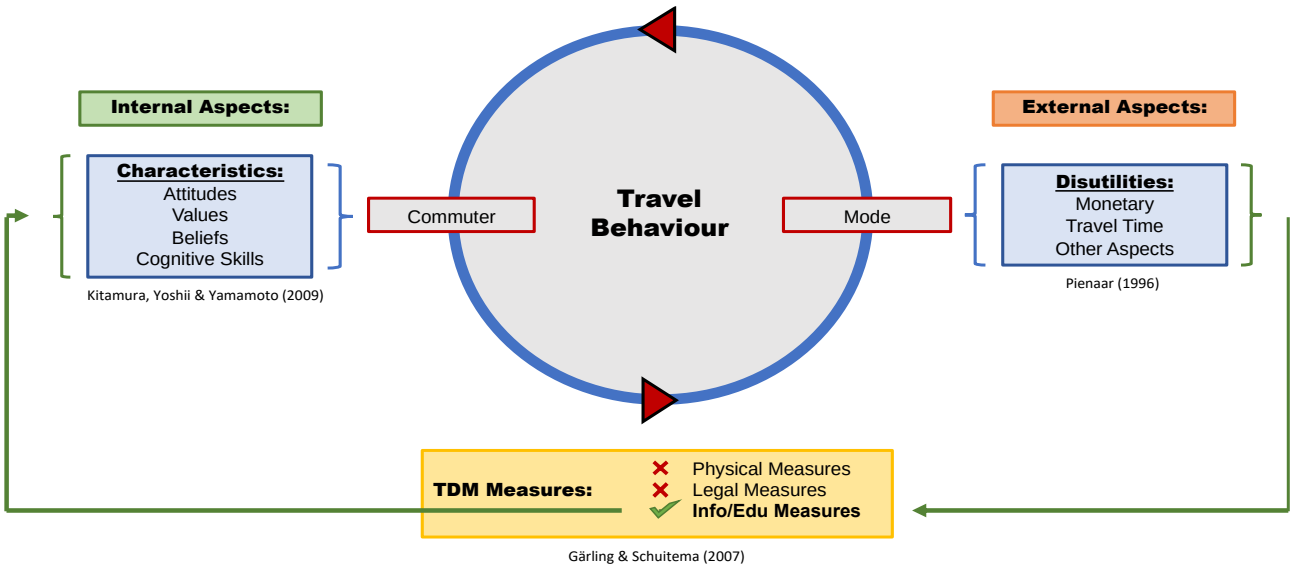

Figure 2.3: Conceptual framework diagram

Source: Author's construct

Figure 2.3 illustrates that travel behaviour can be determined by the transport mode, which has external aspects associated with it, and the commuting individuals, who have internal aspects associated with them. If a reduction in private vehicle usage travel behaviour is desired, given that individuals are assumed to make rational decisions regarding travel, a TDM measure would need to reduce the attractiveness of using private vehicle transport. One potential method of achieving this could be by increasing the perceived disutility (Pienaar, 1996) associated with the transport mode. This could be done by utilising either physical, legal, or informational measures (Gärling & Schuitema, 2007).

The literature review indicated that individuals have the tendency to underestimate the costs associated with private vehicle utilisation (Malecki, 1978). Therefore, the proposed TDM measure to be utilised will be an informational/educational measure. By utilising an informational technique, the measure will be able to impact the internal aspects that influence commuters when making their decisions. These internal aspects are attitudes, values, beliefs, and cognitive skills (Kitamura *et al.*, 2009).

The presentation of accurate cost information regarding the mode of transport, via an information-sharing TDM measure, is therefore expected to influence commuters' perceived values and beliefs regarding these costs and to assist in adjusting them to become more accurate. By doing so, the commuter will ideally use their cognitive skills to determine that their perceived costs were previously underestimated and incorrect, and therefore adjust their behaviour accordingly by utilising their private vehicle less frequently. This adjustment in private vehicle usage should therefore be measurable.

CHAPTER 3:
THE INFORMED TRAVELLER SURVEY DESIGN AND EXPERIMENT

3.1 INTRODUCTION

In order to assess what individuals perceive their costs to be and to be able to compare these costs to the actual costs incurred, information must be gathered. For this research study, detailed, accurate, and reliable data collection regarding participant movements is required. These data will then be presented to participants in the form of informational feedback. Following the feedback given to individuals relating to their costs and travel patterns, further travel behaviour data will be gathered and then compared to the pre-feedback travel patterns, to investigate whether any measurable change was realised.

To achieve a statistically representative sample, the ideal number of individuals tracked would be approximately 350 and the tracking period would ideally take place over an extended period of time (eight or more weeks) to allow for behavioural adjustment, where feedback would be given to the individuals in a regular interval period. This methodology is similar to what was used by Tertoolen *et al*. (1998), who investigated the impacts of sharing cost information with individuals who were being tracked in order to ascertain whether there was any influence on the travel behaviour in terms of private vehicle usage.

The main aim of this research was to assess whether any measurable impact on travel behaviour was identifiable due to the sharing of information. As such, a tracking method that would allow for the collection of accurate and reliable travel data with minimal inconvenience to a participant was needed. It was decided that GPS devices would satisfy these criteria. By utilising the GPS devices, accurate travel behaviour data were attained when the vehicles were in use. The data assisted in the understanding of how cost information facilitates a change in travel behaviour in the short term, while attempting to determine whether these changes were statistically significant and therefore potentially sustainable in the long run.

Furthermore, it was decided that, ideally, participants in this study would need to be employed and pay for their private vehicles themselves. The motivation for wanting employed individuals was due to these individuals usually having a routine regarding travel behaviour, which would be beneficial regarding the detection of any changes in travel behavioural patterns that may be experienced. The reasoning behind wanting individuals to be the ones who pay for the vehicles they use was to ensure

that any alteration in travel behaviour would directly result in monetary cost savings, of which they themselves would receive the full benefit.

3.2 DATA-COLLECTION PROCESS

The data-collection process of this research study consisted of a sign-up form and two questionnaires to be completed by participants, and a vehicle-tracking exercise. The sign-up form was utilised to canvas participants. The first questionnaire was distributed prior to the TDM intervention, while the second questionnaire captured information after the intervention had taken place. The vehicle-tracking exercise was executed by means of installing GPS devices in the participants' vehicles, which enabled the researcher to gather vehicle movement information.

In order to assist in the identification of issues that may have otherwise arisen and to assist in the optimisation of the research method itself, a pilot exercise took place prior to the official study. This pilot exercise consisted of a pilot survey, tracking, comparison, and analysis of collected data, and was aimed at streamlining the process of tracking, data collection, and analysis in the main research study. During this pilot exercise, three individuals, including the author of this dissertation, completed the questionnaires and participated in a short tracking exercise.

With regard to the main research study, in order to canvas potential participants, the researcher created an invitation letter to invite individuals to participate in the survey. This letter was forwarded to the spatial planning and heritage manager of the Stellenbosch Local Municipality, Mr Barnebe de la Bat, on 21 February 2017. The municipality, which was chosen due to its geographic location, circulated the invitation letter to its employees in various departments. The purpose of the invitation letter was to inform potential participants of the possible benefits they could receive, such as personalised cost information relating to their vehicles and travel behaviour. Other relevant details pertaining to the study were also included and can be viewed in greater detail in Addendum A: Invitation Letter. A link to the online sign-up form was incorporated in the invitation letter. The sign-up form requested participants to complete five questions, all of which were compulsory (see Addendum B: Sign-up Form). The questions that the interested participants were requested to complete allowed the researcher to collect the necessary contact information, such as name and contact details. Further information pertaining to whether the interested individuals were suitable to take part in the study, in terms of indication that they utilised their vehicle to travel to work and that their vehicle was manufactured post 1996, which was required due to these vehicles being fitted with an OBD-II port which was needed to connect certain GPS devices, was also inquired. In total, 29 responses were received.

Participants were contacted telephonically, and during the conversation the researcher conveyed further information about the study and answered any questions the participants had. Once the participants were satisfied with the details of the study, the researcher informed them that a more detailed online questionnaire would need to be completed before the study could commence. Prior to concluding the conversation, a meeting time and location were arranged to allow the researcher to install the GPS tracking device in the participant's vehicle. It should be stated that during these telephonic discussions, two individuals felt the need to withdraw from the study as they did not feel comfortable with the fact that their vehicles would be tracked with a GPS device. Due to these participants withdrawing prior to the GPS tracking exercise commencement they were replaced with willing participants . However, the reluctance of individuals to be tracked is therefore still identified as a limitation to studies of this nature. An additional limitation was the available funding required to rent the GPS tracking devices. Only 25 devices were able to be procured and, as such, only 25 participants were able to take part in the study.

The more detailed questionnaire captured various data about the participants, their vehicle, and general travel behaviour/perceptions, and from now onward will be referred to as the first questionnaire. The full questionnaire contained multiple pages and can be reviewed in Addendum C: First Questionnaire.

The vehicle-tracking exercise consisted of tracking the vehicles of 25 individuals for a period of four weeks, from 8 May 2017 to 4 June 2017. During this period, the participants received an informational invoice once every week, excluding the first week, on Monday mornings. The informational invoice informed participants of their travel behaviour patterns and illustrated the amount that their vehicle impacted them financially. Environmental costs associated with the travel behaviour incurred during a weekly period were also conveyed to participants. An outline of the planned schedule regarding the overall tracking period and when the informational invoices would be provided to participants can be found in Addendum D: Research Exercise Timeline. An example of the monetary and environmental invoices can be found in Addendum E: Monetary and Environmental Invoices.

The vehicle-tracking exercise data were collected with GPS devices. The GPS data were collected by two different types of GPS units. This was done, in part, to assess the impact of the device on data quality and accuracy for the possibility of future use in similar research studies. Both GPS device types required installation for use. Device A, the larger of the two devices, was installed into the vehicles' 12V socket (cigarette lighter port) where it would draw power through the port via a cable and then be placed underneath the passenger seat in the cabin of the vehicle. Device B was installed via the On-Board Diagnostics (OBD-II) port, with which all vehicles manufactured post 1996 are

equipped. No additional cabling was required as the device would draw power directly from the OBD port. Images of the devices can be viewed in Figure 3.1 and Figure 3.2.

Figure 3.1: GPS Device A

Source: GPS Logbook

Figure 3.2: GPS Device B

Source: Mtrack

Both GPS devices relayed the relevant GPS information via the Global System for Mobile Communications (GSM) network available to their location, which was then relayed to the servers of the company that hosted the service for the relevant device. The main GPS information available to the researcher included origin-destination locations (latitude and longitude coordinates for Device A, and street names for Device B) of each trip undertaken by the participants, a relevant time stamp indicating when a trip began and ended, as well an indication of the overall distance, average speed, and travel time per trip. The researcher was able to request reports pertaining to the data of each unique GPS device from the company websites. The data found in the reports could be segregated into the following categories of information: start and end times of trips, start and end location of trips, total distance travelled per trip, total time duration per trip, and average speed driven per trip. An example of these weekly datasheets can be observed in Table 3.1 and Table 3.2.

The GPS data were forwarded to company servers, where it would become instantly available on the company's website for the researcher to download and analyse. Figure 3.3 is a graphical representation of the GPS data supply chain process.

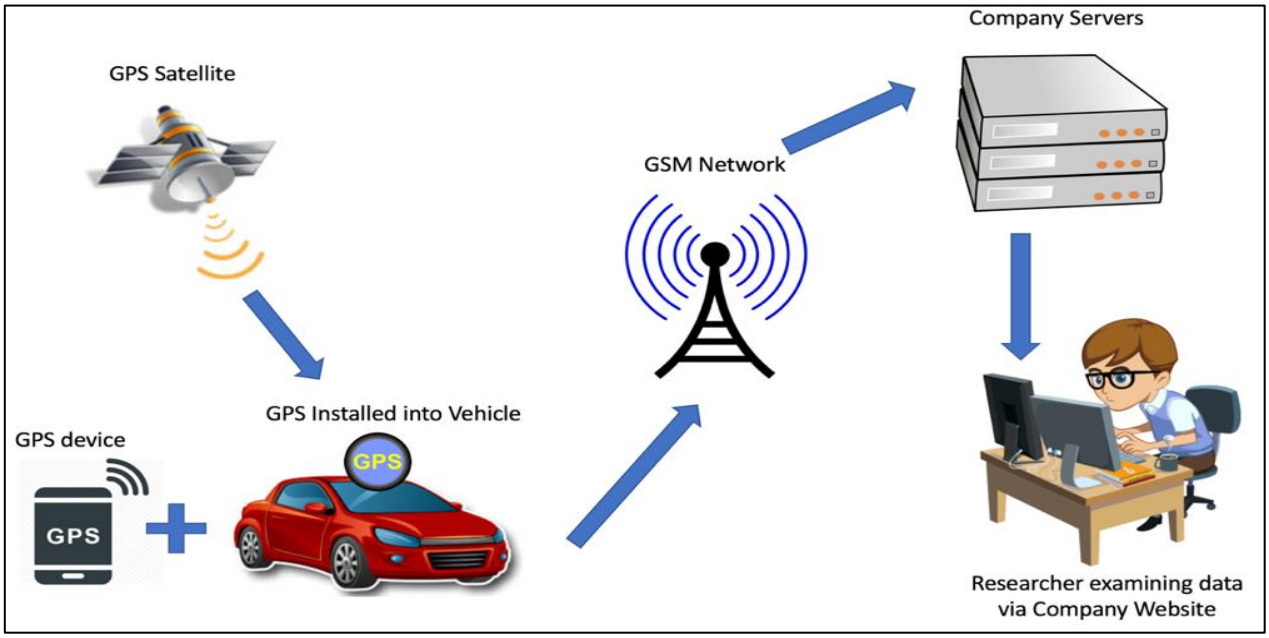

Figure 3.3: GPS data-collection process

Source: Author's construct

The ability to examine the live positioning of the participants allowed the researcher to perform quality control checks. The researcher would log onto the websites to ensure that all GPS devices were transmitting correctly. If it was observed that a device had not been active for three consecutive days, the researcher contacted the corresponding participant to ensure that there was not a technical fault with the device. During the vehicle-tracking exercise, two participants experienced technical problems with the GPS devices. Their data were therefore found to be incomplete and were not considered for analysis of the findings. As such, the study acquired complete datasets for 23 participants during the four-week tracking period. The issues experienced by the two participants will be discussed further in the limitations section of this chapter.

The information gathered from the company websites was used as an input to the invoice datasheets for the participants. The total distance driven per week was also used in the calculation of monetary and environmental cost associated with the participants' travel behaviour. In conclusion, the participants received information pertaining to their total number of trips, total in-vehicle time duration, total distance travelled, total monetary cost, and total environmental cost associated with their travel behaviour for the relevant week of the study.

As mentioned above, the participants were provided with informational invoices that conveyed information regarding the monetary and environmental costs associated with their travel behaviour. The calculations for the informational invoices were based on the Automobile Association of South Africa (AA) rates of South Africa (LeasePlan South Africa, 2016), which can be viewed in Addendum G: Summary of AA Rates. The data used to calculate vehicle emissions were sourced from the New Zealand Transport Agency's (2016) website. The vehicle running costs and emission rates are based on generalised values established by taking various characteristics into consideration and therefore may not be accurate in terms of driving style and the exact vehicle model used by the participants. In addition, the information that the AA rates' calculations were based on relied on the input that participants provided in the first questionnaire.

The formulas utilised for calculating the monetary costs and the environmental cost information that were presented to participants can be expressed as follows:

Equation 3.1: Monetary cost calculation

$$MC = vkm \times \{FC + [SR + TY + (FF \times FP)]\} \quad \text{.....Eq. 1}$$

Where:

MC = monetary cost (in rands per week)
vkm = kilometres driven for the week
FC = fixed cost per kilometre (as found in AA rates)
SR = service and repair cost per kilometre (as found in AA rates)
TY = tyre cost per kilometre (as found in AA rates)
FF = fuel factor (as found in AA rates)
FP = fuel price

Equation 3.2: Environmental cost calculation

$$EC = vkm \times (VFC \times FEF) \quad \text{.....Eq. 2}$$

Where:

EC = environmental cost (in grams of CO_2 emitted per week)
vkm = kilometres driven for the week
VFC = vehicle fuel consumption (as found in AA rates)
FEF = fuel type carbon emissions factor (as found from New Zealand government rates)

Regarding the environmental cost associated with vehicle travel, the carbon emissions calculation was taken further in order to convey the message in a manner that the average person can easily understand. A young tree can absorb approximately 12 kg of CO_2 per annum (Arbor Environmental Alliance, 2008). The weekly carbon emissions generated by participants were multiplied by 52 (weeks per year) and then divided by 12. This yielded the number of trees that would need to be planted in order to absorb the participants' emissions for the year, i.e. making them carbon neutral. In order to estimate the cost of the trees, a value of R40 per tree (Carbon Neutral Pty Ltd, 2015) was assigned and then multiplied with the number of trees needed in order to attain a monetary value associated with making the participant carbon neutral. These values were all included in the informational invoices.

The second questionnaire (see Addendum F: Second Questionnaire) that the participants were requested to complete following the return of their GPS device, consisted of a single page, and the link to the online questionnaire was communicated to participants via email. This questionnaire was used as a comparison mechanism to detect any variance in perceptions that participants may possibly have incurred due to the implemented intervention technique. The participants were requested to firstly identify themselves; following this, they were tasked with responding to four questions that they had also answered in the first questionnaire. The final three questions were new and inquired whether the participants found the invoices presented during the study beneficial/informative, whether they would prefer to receive informational invoices on a weekly or monthly basis for future reference, and the final question requested participants to indicate whether they would be interested in taking part in a research study that will be administered by a PhD candidate in the near future.

3.3 LIMITATIONS

As mentioned previously, certain limitations and problems were experienced in the study. One of these was individuals' lack of willingness to participate. Only a small number of individuals identified that they were fully willing to participate even though the invitation letter was circulated multiple times throughout various departments of the Stellenbosch Local Municipality. It is assumed that the lack of willingness may have been due to the lack of a tangible reward, as the only reward participants would receive was information regarding their private vehicle travel behaviour in terms of monetary and environmental costs. The individuals who declined to take part in the study perhaps believed that they understood their costs associated with their vehicles and therefore did not view the information as beneficial. Another reason for individuals being hesitant to take part is that they did not feel comfortable with their vehicle being tracked during a research study. This hesitation came to light during a discussion with two potential participants who withdrew their interest once they were

informed of the GPS tracking involved in the study. It can be assumed that these individuals were primarily concerned with their privacy and safety regarding location tracking.

The research study consisted of a relatively small sample group, comprising only 25 individuals, with 23 participants actually completing the tracking exercise due to technical faults with two of the 25 devices. Regarding the GPS devices, the number of devices available to be used in this study can be considered as a limitation. Another limitation can be identified as the fact that two different GPS devices were used to track participants. The researcher of this study only had access to 4 GPS type A devices, which were already owned by Stellenbosch University, and 21 type B devices, which were rented from Mtrack. The reason for renting different devices to the ones already owned by the university was due to the unavailability of renting similar devices to the ones already owned. It a should be noted that of the two GPS devices available for installation for the research, the participants stated a preference for Device B. Reasons included that devices did not use the 12V lighter port, as was the case for GPS Device A, and thus did not inhibit the utilisation of the port for, for example, cellular phone charging. GPS Device B was also less visible than GPS Device A due to the device utilising the OBD port within the vehicle's cabin, and hence decreased the likelihood of criminals breaking into participants' vehicles, which was a concern expressed by multiple participants.

The two types of GPS devices may have some accuracy discrepancies between them and as such may cause issues regarding the overall accuracy of the GPS tracking exercise. Additionally, as with all GPS devices, there is a general "cold start" issue (Duncan, Badland & Mummery, 2009) that influences the general accuracy of GPS devices while they are attempting to identify (or fix) their location, which could result in some distances, especially the initial travel distances, not being recorded.

One of the participants was asked to have both types of devices installed for a period of two weeks. During this period, the participant would email the researcher the odometer reading every Monday morning before the first vehicle trip. This allowed the researcher to test the accuracy of the two devices in comparison to the actual distance driven as per the odometer reading. Overall, it was found that there was a loss in distance travel measurement of 1% when compared to the odometer reading, and this distance loss was true for both sets of devices.

The vehicle tracking period was selected in such a manner that public holidays and fuel price fluctuations present in South Africa did not occur during the four-week tracking period. It is assumed that individuals commuted to work regularly and that there would not be any unusual travel behaviour present due to public holiday periods or any possible changes in the fuel price. It should be mentioned, however, that the tracking period did coincide with the conclusion of on-campus university lectures

and the beginning of examinations, which may have had an impact on overall congestion present in the municipal area of Stellenbosch. Additionally, the tracking period took place during the autumn-winter period of South Africa, and this period may have influenced the participants' inclination to use various methods of transportation such as walking or cycling due to the relatively colder weather and increased levels of precipitation in the Western Cape. Stellenbosch does not have a robust public network that most private vehicle users feel is sufficient for their needs, as can be concluded from the findings in the questionnaire; which will be discussed further in the analysis section.

Two participants did not complete the tracking exercise. In both cases the devices were removed because the participants experienced discomfort or general inconvenience associated with the GPS device. One participant accidentally dislodged the device when entering their vehicle, which caused the device to disconnect from the OBD port. This resulted in the participant's tracking data being incomplete. The other participant removed the device after a certain period as they claimed that due to the location of the vehicle's OBD port, the device was situated in a position that made driving the vehicle uncomfortable as the device consistently made contact with the participant's leg while operating the vehicle. As a result, the corresponding data collected from these two participants were not taken into consideration during any part of the analysis.

The potential limitation of participants not receiving or reading their informational invoices is believed to have been mitigated by the fact that the researcher had the opportunity to meet each participant and present an in-depth explanation of the invoices. This allowed the researcher to clarify any queries that the participants had, while additionally allowing the participants to receive the researcher's contact details in the event that any issues regarding the informational invoices arose.

The tracking period of this study lasted four weeks. Travel behavioural patterns associated with individuals have been shown to be habitual (Gärling, Eek, Loukopoulos, Fujii, Johansson-Stenman, Kitamura, Pendyala & Vilhelmson, 2002) due to the habitual nature of travel behaviour, and because habits require a varying amount of time before they can be altered, it is possible that a single month of informational intervention was not long enough to impact the habitual behaviour of the individuals.

On a final note, it should be stated that there is always the possibility that participants may have been mistaken when answering certain questions. Any incorrect answers may have caused the results indicated in the informational invoices to be incorrect. A limitation of the study is therefore that the researcher had to rely on the participants understanding what was asked of them and that they provided correct values to the various questions in the first questionnaire.

In terms of the second questionnaire, one final limitation was present. Once the tracking period had been completed and GPS devices collected, participants were emailed a link to complete the second

and final questionnaire within an allotted period. The cut-off date was two weeks after the completion of the tracking exercise. Of the 23 participants who had completed the tracking exercise correctly, only 19 completed the final questionnaire. This can potentially be viewed as participants simply losing interest in the research study and therefore not wishing to complete the final questionnaire.

3.4 ETHICAL CLEARANCE

Considering that this research study handled potentially sensitive data, prior to commencement of the study the researcher applied for ethical clearance from the Departmental Ethics Screening Committee (DESC) of Stellenbosch University. Once approval from the DESC was attained, the process was forwarded to the Stellenbosch University Research Ethics Committee (SU REC) for final approval.

The application process consisted of outlining the methodology that the research study would follow. During this process it was highlighted that the participants were not to be named or singled out in the study in order to maintain confidentiality and were only to be referred to as collective groups. Furthermore, any individuals who did not wish to participate or who reconsidered their original decision during or after tracking had commenced were to have no negative implications imposed upon them. Participants were also unrestricted with regard to withdrawing from the study at any point they felt inclined to do so.

In order to ensure the safekeeping of the tracking data, personal information, and any other sensitive data, only the author of this study, and his supervisor, had access to the datasets. The datasets were stored on the author's personal computer, which was kept secure by means of a security password. Any documentation that was not completed electronically was locked up in the author's personal locker. Finally, the method of acquiring consent and personal information was handled by placing a disclaimer at the beginning of the survey to inform individuals of all the parameters stated above; this was also performed in a professional and sensitive manner.

Additionally, the submission of all data-capturing mechanisms, such as the sign-up form and the first and second questionnaires, was presented in conjunction with the invitation letter that was sent out to potential participants. On 24 April 2017, the researcher received notice that his ethical clearance had been officially approved by the SU REC by means of an official letter (see Addendum H: Ethical Clearance Approval Letter).

3.5 DATA ACCESSING, CLEANING, AND RULES

The GPS data was download from the respective GPS service providers' websites. The online dashboards for the two GPS service providers were presented differently. However, the data that was

extracted from these websites were found to be in similar formats and the same relevant information could be attained in order to analyse the data. Both device types would begin tracking participants' vehicle movements from the moment vehicles engine was turned on. However if the vehicle was found to be stationary for a significant period of time, the GPS device would log the movement as a trip, even when the engine remained turned on. Both datasets extracted from the GPS service providers contained Street name data, however data from Mtrack (which provided the devices which connected to the cars OBD port) did not provide GPS coordinate, maximum speed during trip or stop duration between trip information.

From this point on, the GPS devices that were inserted into the 12V lighter port of the vehicles' cabin are referred to as GPS Device Type A. GPS Device Type B refers to the GPS devices that were installed by attaching them to the vehicles' OBD port. Table 3.1 and Table 3.2 show the raw data for two different devices, one being GPS Type A and the other being GPS Type B, over the same one-week period.

Table 3.1: Raw data for GPS Type A device

Vehicle	Designation	Categories	Start Date	Start Time	End Date	End Time	Start Zone	Start Latitud	Start Longitu	End Zone	End Latitude	End Longituc	Distance (km	Duration	Avg Speed (k	Max Speed (l	Comment	Running Cos	Stop Duration
GPS2	Private	Uncategorize	08/05/2017	11:07:42	08/05/2017	11:11:15	Hofmeyr Stre	-34.188039	22.143796	George Road	-34.181214	22.1410065	1.35	00:03:33	22	52			00:11:00
GPS2	Private	Uncategorize	08/05/2017	11:22:15	08/05/2017	11:31:59	George Road	-34.181214	22.1410065	Spekboom St	-34.195165	22.0912902	6.68	00:09:44	41	71			01:55:32
GPS2	Private	Uncategorize	08/05/2017	13:27:31	08/05/2017	13:38:10	Spekboom St	-34.195165	22.0912902	Hofmeyr Stre	-34.188027	22.1438009	6.65	00:10:39	37	88			03:41:57
GPS2	Private	Uncategorize	08/05/2017	17:20:07	08/05/2017	17:24:11	Hofmeyr Stre	-34.188027	22.1438009	Da Gama Str	-34.181942	22.1329625	1.56	00:04:04	23	36			01:15:55
GPS2	Private	Uncategorize	08/05/2017	18:40:06	08/05/2017	18:44:20	Alhof Drive, I	-34.180962	22.1324909	Hofmeyr Stre	-34.188045	22.1437876	1.65	00:04:14	23	47			17:52:59
GPS2	Private	Uncategorize	09/05/2017	12:37:19	09/05/2017	12:55:37	Hofmeyr Stre	-34.188045	22.1437876	Spekboom St	-34.195241	22.0911131	7.86	00:18:18	25	74			01:25:29
GPS2	Private	Uncategorize	09/05/2017	14:21:06	09/05/2017	14:36:34	Spekboom St	-34.195241	22.0911131	Carissa Stree	-34.189866	22.1312567	8.04	00:15:28	31	71			01:07:26
GPS2	Private	Uncategorize	09/05/2017	15:44:00	09/05/2017	15:47:18	Carissa Stree	-34.189866	22.1312567	Hofmeyr Stre	-34.188015	22.1438071	1.25	00:03:18	22	41			17:11:57
GPS2	Private	Uncategorize	10/05/2017	08:59:15	10/05/2017	09:09:42	Hofmeyr Stre	-34.188015	22.1438071	Gericke Roac	-34.144789	22.1013646	7.08	00:10:27	40	68			00:08:09
GPS2	Private	Uncategorize	10/05/2017	09:17:51	10/05/2017	10:18:39	Gericke Roac	-34.144705	22.1015506	N12, South C	-33.575786	22.3344061	92.31	01:00:48	91	122			00:07:04
GPS2	Private	Uncategorize	10/05/2017	10:25:43	10/05/2017	11:33:27	N12, South C	-33.575786	22.3344061	Market Stree	-33.216897	22.0262511	98.35	01:07:44	87	118			01:25:36
GPS2	Private	Uncategorize	10/05/2017	12:59:03	10/05/2017	14:02:04	Market Stree	-33.216897	22.0262511	N12, South C	-33.561658	22.3771682	93.65	01:03:01	89	123			00:09:44
GPS2	Private	Uncategorize	10/05/2017	14:11:48	10/05/2017	15:27:54	N12, South C	-33.561658	22.3771682	Hofmeyr Stre	-34.188045	22.143909	103.71	01:16:06	81	120			02:16:24
GPS2	Private	Uncategorize	10/05/2017	17:44:18	10/05/2017	17:48:23	Hofmeyr Stre	-34.188045	22.143909	Aristea Stree	-34.193197	22.134283	1.17	00:04:05	17	35			01:39:43
GPS2	Private	Uncategorize	10/05/2017	19:28:06	10/05/2017	19:31:33	Aristea Stree	-34.193197	22.134283	Hofmeyr Stre	-34.188058	22.1438028	1.25	00:03:27	21	39			12:04:17
GPS2	Private	Uncategorize	11/05/2017	07:35:50	11/05/2017	08:16:17	Hofmeyr Stre	-34.188058	22.1438028	Pine Lodge, (	-33.968547	22.4881973	55.69	00:40:27	82	128			05:37:57
GPS2	Private	Uncategorize	11/05/2017	13:54:14	11/05/2017	14:05:15	Pine Lodge, (	-33.968547	22.4881973	Cathedral Str	-33.957713	22.4592176	3.35	00:11:01	18	48			00:07:09
GPS2	Private	Uncategorize	11/05/2017	14:12:24	11/05/2017	14:53:57	Cathedral Str	-33.957713	22.4592176	Spekboom St	-34.195318	22.0911837	54.92	00:41:33	79	127			01:10:07
GPS2	Private	Uncategorize	11/05/2017	16:04:04	11/05/2017	16:14:08	Spekboom St	-34.195318	22.0911837	Hofmeyr Stre	-34.188042	22.1438028	6.66	00:10:04	39	75			22:52:24
GPS2	Private	Uncategorize	12/05/2017	15:06:32	12/05/2017	15:11:07	Hofmeyr Stre	-34.188042	22.1438028	Da Gama Str	-34.181597	22.1327778	1.61	00:04:35	21	49			00:15:35
GPS2	Private	Uncategorize	12/05/2017	15:26:42	12/05/2017	15:31:21	Da Gama Str	-34.181597	22.1327778	Hofmeyr Stre	-34.188015	22.1437986	1.61	00:04:39	20	47			22:41:42
GPS2	Private	Uncategorize	13/05/2017	14:13:03	13/05/2017	14:18:02	Hofmeyr Stre	-34.188015	22.1437986	Alhof Drive, I	-34.181299	22.1328143	1.64	00:04:59	19	46			00:08:30
GPS2	Private	Uncategorize	13/05/2017	14:26:32	13/05/2017	14:30:17	Da Gama Str	-34.18202	22.1333481	Hofmeyr Stre	-34.188012	22.1437779	1.53	00:03:45	24	48			19:30:33
GPS2	Private	Uncategorize	14/05/2017	10:00:50	14/05/2017	10:05:51	Hofmeyr Stre	-34.188012	22.1437779	Alhof Drive, I	-34.181282	22.1327881	1.62	00:05:01	19	41			00:06:57
GPS2	Private	Uncategorize	14/05/2017	10:12:48	14/05/2017	10:21:15	Alhof Drive, I	-34.181282	22.1327881	Hofmeyr Stre	-34.188061	22.1438873	2.98	00:08:27	21	54			05:05:03
GPS2	Private	Uncategorize	14/05/2017	15:26:18	14/05/2017	15:30:22	Hofmeyr Stre	-34.188061	22.1438873	Aristea Stree	-34.193155	22.134256	1.16	00:04:04	17	32			02:08:18
GPS2	Private	Uncategorize	14/05/2017	17:38:40	14/05/2017	17:41:48	Aristea Stree	-34.193155	22.134256	Hofmeyr Stre	-34.188051	22.1438054	1.15	00:03:08	22	39			

Source: Compiled by author from GPS data

Table 3.2: Raw data for GPS Type B device

Assets: Vehicle "TBI-04"						
From: 2017/05/08 00:00						
To: 2017/05/14 23:59						
Minimum Distance: 0.1 km						
TBI-04						
Start	End	From	To	Distance	Duration	Avg Speed
08/05/2017 06:14	08/05/2017 06:38	Silverboom K	Hammansha	19.6 km	0h 23m	49 km/h
08/05/2017 18:08	08/05/2017 18:36	Adam Tas Str	Oldenland St	19.8 km	0h 28m	42 km/h
09/05/2017 06:26	09/05/2017 06:51	Silverboom K	Hammansha	18.2 km	0h 25m	42 km/h
09/05/2017 17:16	09/05/2017 17:52	Jan Cilliers St	Centenary Di	19.8 km	0h 36m	33 km/h
09/05/2017 18:00	09/05/2017 18:03	Forsyth Roac	Forsyth Roac	0.2 km	0h 03m	3 km/h
09/05/2017 18:18	09/05/2017 18:22	Centenary Di	Firgrove Rura	0.2 km	0h 03m	4 km/h
09/05/2017 22:39	09/05/2017 22:52	Centenary Di	Oldenland St	7.4 km	0h 12m	35 km/h
10/05/2017 07:39	10/05/2017 08:16	Silverboom K	Krommerivie	20.2 km	0h 37m	33 km/h
10/05/2017 12:38	10/05/2017 12:43	Hammansha	Cluver, Stelle	1.0 km	0h 05m	11 km/h
10/05/2017 12:48	10/05/2017 12:57	Culver Street	Jonkershoek	5.6 km	0h 09m	37 km/h
10/05/2017 15:37	10/05/2017 16:18	Jonkershoek	Oldenland St	27.3 km	0h 41m	39 km/h
11/05/2017 16:27	11/05/2017 16:40	Irene Avenue	Aries Lane, N	9.8 km	0h 12m	46 km/h
11/05/2017 17:32	11/05/2017 17:44	Aquarius Ave	Thunberg Av	7.2 km	0h 12m	36 km/h
11/05/2017 19:42	11/05/2017 19:53	Main Road, S	Oldenland St	5.9 km	0h 11m	32 km/h
12/05/2017 09:31	12/05/2017 09:37	Oldenland St	Solomon Stre	2.3 km	0h 05m	24 km/h
12/05/2017 10:02	12/05/2017 11:49	Dummer Stre	Prospect Roa	42.9 km	1h 47m	24 km/h
13/05/2017 10:07	13/05/2017 10:29	Oldenland St	Condolier La	13.6 km	0h 21m	37 km/h
13/05/2017 10:07	13/05/2017 11:58	Oldenland St	Centenary Di	21.5 km	1h 50m	12 km/h
13/05/2017 12:57	13/05/2017 13:12	Centenary Di	Oldenland St	7.6 km	0h 15m	30 km/h
13/05/2017 13:18	13/05/2017 13:27	Oldenland St	Main Road, S	4.9 km	0h 09m	32 km/h
13/05/2017 16:56	13/05/2017 17:07	Thunberg Av	Oldenland St	5.9 km	0h 11m	32 km/h
21 trips				260.9 km	9h 03m	30 km/h

Source: Compiled by author from GPS data

Table 3.2 illustrates the different raw data format available. The variables used for calculations and information sharing include the number of trips (derived from the number of rows present as each row indicates one trip), the distance covered per trip, the duration of each trip, and the average speed per trip.

The data were cleaned and formatted into two types of summary data for the devices – one daily and one weekly. Daily and weekly summaries were obtained for distance travelled, time spent travelling, and number of trips. Table 3.4 shows the weekly summary, including distance, duration, and number of trips.

Table 3.3: Daily summary of device distance covered in kilometres

Month	MAY																									JUNE			
Week	Week 1										Week 2							Week 3								Week 4			
Date	08/05/17	09/05/17	10/05/17	11/05/17	12/05/17	13/05/17	14/05/17	15/05/17	16/05/17	17/05/17	18/05/17	19/05/17	20/05/17	21/05/17	22/05/17	23/05/17	24/05/17	25/05/17	26/05/17	27/05/17	28/05/17	29/05/17	30/05/17	31/05/17	01/06/17	02/06/17	03/06/17	04/06/17
Device/ Day	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
TBI 1	7.4	8.4	8.3	26.0	33.2	43.1	0.0	6.3	46.4	78.5	48.4	128.7	13.1	59.0	5.6	26.7	28.4	28.2	34.2	53.6	11.3	25.6	28.1	55.4	25.9	111.7	38.3	26.6
TBI 2	186.5	17.8	96.7	2.5	5.1	82.8	0.0	0.0	38.0	1.1	16.3	62.6	92.1	85.1	18.3	29.1	9.1	81.8	28.5	0.0	38.5	0.8	20.6	0.2	138.9	106.5	13.9	1.7
TBI 3	60.4	66.2	21.9	55.9	59.6	0.0	0.0	56.6	58.4	55.0	55.6	57.4	0.0	0.0	68.2	66.1	54.4	29.1	57.9	6.0	1.0	55.1	56.9	57.5	55.9	58.8	0.0	0.0
TBI 4	39.4	45.8	54.1	22.9	45.2	53.5	0.0	38.0	40.6	42.3	0.0	151.0	17.6	0.0	50.7	68.9	52.8	114.9	13.3	16.7	18.8	39.6	56.9	50.5	44.4	64.5	14.5	0.0
TBI 6	56.8	55.0	55.7	63.3	37.4	25.9	173.7	100.9	42.3	88.7	72.5	49.1	0.0	17.4	88.9	60.7	55.3	54.2	560.8	9.9	588.0	43.1	95.5	67.9	65.1	202.0	90.0	34.8
TBI 7	8.9	24.4	16.1	20.6	14.7	116.9	44.8	19.1	23.0	15.3	14.6	53.7	92.1	87.8	9.9	18.9	23.6	14.7	14.0	98.9	56.1	11.6	9.2	13.6	31.0	8.2	92.5	62.6
TBI 8	16.3	236.5	31.5	26.7	21.8	5.4	11.4	15.0	15.5	19.7	14.7	43.3	4.0	6.1	14.0	13.5	16.0	6.5	18.1	0.0	14.7	17.3	16.3	8.9	16.0	3.6	15.4	8.7
TBI 9	30.9	7.4	14.0	18.7	25.5	0.0	16.5	0.0	4.3	12.7	2.9	12.1	0.0	0.0	15.6	0.9	7.6	62.0	2.9	0.0	0.0	10.9	6.8	20.3	44.5	27.3	0.0	37.2
TBI 10	15.4	13.9	18.5	12.5	13.0	0.0	222.7	15.5	16.8	12.5	12.7	18.5	0.0	31.6	30.3	12.2	20.0	17.9	14.5	23.8	213.0	8.2	0.0	0.0	0.0	2.6	26.7	212.9
TBI 11	25.7	17.2	9.9	13.0	9.3	18.7	1.1	9.7	81.0	3.3	90.7	20.0	14.4	5.2	0.0	91.0	23.8	17.4	11.3	54.4	43.5	15.1	18.1	11.0	103.9	23.3	5.4	14.0
TBI 12	83.2	107.4	86.4	127.4	84.2	43.7	18.8	105.7	86.5	83.9	105.9	85.3	35.3	11.4	85.3	89.2	118.8	112.8	120.5	102.1	19.9	101.2	119.5	158.0	91.6	121.1	110.3	40.4
TBI 13	116.7	8.2	10.8	20.7	3.6	113.3	1.6	4.1	3.2	3.1	2.9	6.9	10.6	31.0	7.6	5.6	4.5	3.7	3.6	1.2	0.0	4.1	4.9	4.6	0.0	0.0	0.0	0.0
TBI 14	0.0	8.8	12.2	9.0	8.2	16.9	7.0	15.5	73.3	130.0	252.1	12.6	0.0	5.6	384.9	497.6	13.0	11.6	9.3	30.8	100.2	14.2	125.2	145.3	17.9	377.0	18.3	24.9
TBI 15	7.3	12.3	10.2	9.8	116.4	2.3	207.5	20.9	12.9	12.5	10.5	77.3	71.1	0.0	15.2	13.4	13.5	7.9	6.8	0.0	0.0	14.3	16.2	64.7	15.2	44.6	0.0	0.0
TBI 16	78.3	80.6	78.2	78.2	79.5	0.0	0.0	78.3	77.4	81.5	77.2	80.2	11.7	0.0	79.0	76.8	76.1	38.6	78.3	0.0	0.0	5.4	0.0	0.0	0.0	0.0	16.6	0.0
TBI 17	18.9	41.0	20.0	31.9	36.3	9.7	78.4	54.0	41.1	42.5	27.9	33.5	7.4	4.5	28.9	33.5	27.1	28.8	33.0	20.1	10.9	36.7	28.7	40.0	29.1	23.4	14.7	16.5
TBI 18	95.3	94.6	93.2	0.0	197.0	14.4	76.5	99.7	90.4	93.0	43.5	159.1	15.9	2.4	96.2	96.5	103.8	91.2	98.3	13.1	0.0	4.6	6.9	2.4	181.4	135.7	16.5	181.4
TBI 20	104.1	0.0	101.0	6.2	158.8	0.0	160.6	105.9	107.6	7.3	106.5	72.2	0.0	0.0	15.0	0.0	7.1	12.0	2.2	74.7	103.7	117.7	14.2	107.4	106.8	17.8	0.0	5.5
TBI 21	11.2	118.4	10.7	15.6	7.7	0.0	0.0	15.7	12.6	113.5	140.6	27.6	96.4	92.8	99.3	15.3	24.5	11.3	402.8	0.0	0.0	103.7	0.0	0.0	30.5	25.4	342.5	95.5
GPS 1	377.2	7.6	14.3	5.1	12.5	13.3	112.6	8.9	5.6	6.2	21.7	5.4	38.6	43.6	24.9	6.0	17.2	45.9	50.3	0.0	0.0	52.3	23.6	23.6	13.6	20.8	0.0	20.4
GPS 2	17.9	17.2	397.5	120.6	3.2	3.2	6.9	2.7	280.6	282.2	105.0	2.6	0.0	4.7	281.7	14.0	277.1	117.2	24.9	0.0	0.0	0.0	280.1	541.4	0.0	0.0	0.0	2.9
GPS 3	70.7	61.1	0.0	0.0	0.0	7.8	0.0	67.7	3.6	19.3	5.0	0.0	13.8	8.1	67.5	69.9	69.4	73.3	70.4	57.6	3.2	67.4	65.5	68.0	4.1	0.0	49.3	1.2
GPS 4	56.2	44.7	44.5	47.2	44.6	7.1	0.5	44.6	46.8	45.8	47.1	15.7	37.9	10.6	47.4	52.3	52.9	44.5	57.2	0.0	17.0	49.5	44.7	44.5	55.9	46.0	11.4	50.0
TOTAL	1484.6	1094.4	1205.7	733.9	1016.8	577.9	1140.7	884.8	1207.8	1249.9	1274.3	1174.8	572.0	506.9	1534.3	1358.2	1096.0	1025.5	1713.2	562.9	1239.8	798.4	1037.8	1485.1	1071.7	1420.3	876.3	837.2
AVG	64.5	47.6	52.4	31.9	44.2	25.1	49.6	38.5	52.5	54.3	55.4	51.1	24.9	22.0	66.7	59.1	47.7	44.6	74.5	24.5	53.9	34.7	45.1	64.6	46.6	61.8	38.1	36.4
MEDIAN	39.4	24.4	20.0	20.6	25.5	9.7	7.0	19.1	41.1	42.3	43.5	43.3	13.1	6.1	30.3	29.1	24.5	29.1	28.5	9.9	11.3	17.3	20.6	40.0	30.5	25.4	14.7	16.5

Source: Compiled by author from GPS data

Table 3.4: Weekly summary for device distance, duration, and number of trips

	Week 1			Week 2			Week 3			Week 4		
	DIST (km)	TIME (h:m:s)	TRIPS	DIST (km)	TIME (h:m:s)	TRIPS	DIST (km)	TIME (h:m:s)	TRIPS	DIST (km)	TIME (h:m:s)	TRIPS
TBI - 01	126.4	05:35:00	27	380.4	11:57:00	49	188	07:36:00	40	311.6	10:02:00	43
TBI - 02	391.4	09:19:00	32	295.2	09:56:00	32	205.3	06:45:00	39	282.6	07:11:00	30
TBI - 03	264	06:18:00	25	283	06:09:00	15	282.7	07:48:00	33	284.2	06:04:00	15
TBI - 04	260.9	08:02:00	21	289.5	07:07:00	17	336.1	02:44:00	32	270.4	07:23:00	19
TBI - 05												
TBI - 06	467.8	10:16:00	41	370.9	09:34:00	37	1417.8	07:16:00	39	598.4	04:51:00	16
TBI - 07	246.4	07:34:00	38	305.6	09:00:00	39	236.1	07:36:00	40	228.7	07:24:00	41
TBI - 08	349.6	08:51:00	46	118.3	04:33:00	32	82.8	03:45:00	32	86.2	03:51:00	31
TBI - 09	113	03:37:00	35	32	01:12:00	11	89	02:27:00	16	147	03:29:00	27
TBI - 10	296	05:59:00	18	107.6	04:31:00	20	331.7	07:12:00	21	250.4	03:22:00	8
TBI - 11	94.9	05:40:00	43	224.3	07:41:00	35	241.4	08:22:00	35	190.8	08:00:00	52
TBI - 12	551.1	12:33:00	51	514	09:26:00	32	648.6	02:08:00	44	742.1	04:00:00	62
TBI - 13	274.9	09:13:00	31	61.8	03:38:00	20	26.2	03:01:00	16	13.6	01:38:00	8
TBI - 14	62.1	04:08:00	18	489.1	10:37:00	28	1047.4	04:50:00	40	722.8	04:43:00	38
TBI - 15	365.8	07:45:00	28	205.2	05:19:00	27	56.8	02:19:00	20	155	04:06:00	21
TBI - 16	394.8	06:58:00	14	406.3	07:07:00	16	348.8	05:53:00	9	22	12:51:00	4
TBI - 17	236.2	09:18:00	27	210.9	07:47:00	22	182.3	08:43:00	26	189.1	07:11:00	27
TBI - 18	571	12:47:00	39	504	11:55:00	44	499.1	11:33:00	35	528.9	10:53:00	42
TBI - 19												
TBI - 20	530.7	08:52:00	16	399.5	06:24:00	13	214.7	06:30:00	20	369.4	07:35:00	16
TBI - 21	163.6	04:15:00	22	499.2	11:12:00	46	553.2	09:20:00	34	597.6	08:37:00	23
GPS - 1	542.49	09:56:30	24	129.91	04:29:53	22	144.21	05:46:44	26	154.24	06:36:33	30
GPS - 2	566.48	08:16:39	27	677.85	08:47:15	23	714.98	10:04:05	30	824.47	09:45:41	12
GPS - 3	139.6	03:40:56	11	117.45	03:39:20	19	411.31	09:52:21	28	255.37	06:18:55	21
GPS - 4	244.67	05:49:51	18	248.45	05:31:32	19	271.21	06:19:14	19	301.83	07:35:34	24
GPS - 5												
SUM	**7253.84**	**174:43:56**	**652**	**6870.46**	**167:33:00**	**618**	**8529.71**	**207:50:24**	**674**	**7526.71**	**165:27:43**	**610**
AVG	**315.384348**	**7:35:49**	**28.3478261**	**298.715652**	**7:17:05**	**26.8695652**	**370.856957**	**9:02:11**	**29.3043478**	**327.248261**	**7:11:38**	**26.5217391**
MEDIAN	**274.9**	**7:45:00**	**27**	**289.5**	**7:07:00**	**23**	**271.21**	**7:48:00**	**32**	**270.4**	**7:11:00**	**24**

Source: Compiled by author from GPS data

In the above and subsequent datasets, TBI 1-21 represent GPS Type B devices, whereas GPS 1-5 represent Type A devices. It should be noted that the code TBI (for GPS Type B devices), was simply used as an identifier by the device manufacturers and has no specific meaning. In the above tables, TBI 5, TBI 19, and GPS 5 were intentionally left empty, indicated by the grey rows. As mentioned previously, two devices – TBI 5 and GPS 5 – were disconnected by participants during the tracking exercise and therefore could not be used for analysis. TBI 19 was used as a comparison device to test for accuracy with GPS 4 and has as a result remained intentionally blank in order to avoid double counting.

It should be mentioned that there were several instances where single-trip duration data did not seem to relate with the distance travelled during that trip. For example, a trip with a distance of approximately 15 km was captured as taking several hours to complete. In such cases, the researcher assumed that the corresponding GPS device may have incorrectly remained engaged and did not log the duration of the trip correctly. As such, the researcher attempted to identify a similar trip distance within the dataset for that specific device during the given week and utilised its duration to adjust the duration period of the incorrect trip data. The average speed for the identified trip was also adjusted thereafter. A final mention should be made that these trip inconsistencies were rare and therefore the adjustments made should not have had any significant impact on the overall generalisation of summary data.

3.6 SUMMARY

Chapter 3 discussed the methodology followed during the process of data collection for the research exercise. The chapter opened with the ideal number of participants and exercise duration in order to allow for meaningful statistically relevant analysis to take place (a minimum of 350 participants, for a period of eight or more weeks). Unfortunately, due to various funding and time constraints, these were not feasible for this research exercise. As such, 25 individuals, two of whom failed to complete the tracking period due to technical difficulties, were tracked for a period of four weeks. The individuals were identified through an invitation letter that was circulated to Stellenbosch Local Municipality employees on behalf of the researcher. The participants were required to fulfil certain criteria and to complete a questionnaire prior to the tracking period.

GPS devices were utilised for the tracking due to their accuracy, reliability, and minimal input required from participants when compared to other methods of vehicle tracking such as travel diaries and odometer readings. The GPS tracking devices were installed in the participants' vehicles by the researcher. During the four-week research exercise, the participants were informed of the costs associated with their travel behaviour via informational invoices created by the researcher. Following

the tracking period, the participants were requested to complete a final questionnaire that would be used to investigate whether their perceptions shifted after being exposed to the informational invoices. Of the 23 participants who had completed the tracking research exercise, only 19 completed the final questionnaire.

The limitations regarding this study were also discussed in detail. Some of the highlighted limitations included the lack of public willingness to be tracked via GPS (as individuals feel this is an invasion of privacy), as well as the limited sample size and exercise duration period of this study. Following this, the process of obtaining ethical clearance was discussed, where the safeguards and various procedures were identified and put in place to maintain participant confidentiality and to ensure that participant data were securely stored. Finally, the chapter concluded with a discussion of the process for accessing participant data and the methods followed to clean the data and to ensure that the data from the two different GPS devices were directly comparable so that the datasets could be correctly formatted for further analysis.

CHAPTER 4:
STELLENBOSCH UNIVERSITY MOBILITY STUDY

4.1 INTRODUCTION

The aim of this chapter is to investigate whether certain segments of the population are more willing to reduce their private vehicle usage when responding to various factors that may encourage them to do so (motivating drivers). This analysis assists in identifying participants who would be more inclined to reduce their private vehicle usage when exposed to various types of informational- or educational-based TDM measures.

The dataset analysed in this chapter was acquired through Stellenbosch University and formed part of the Stellenbosch University Transport Mobility Study (hereafter referred to as the Mobility Study) (see Venter, Hitge, Krygsman & Thiart, 2018). The purpose of the Mobility Study was to understand the barriers and opportunities that participants encounter when travelling to and on campus, as well as what this meant in terms of their safety and mobility. To achieve the Mobility Study's goal, researchers analysed transport and activity patterns utilising a questionnaire and travel diary, in addition to a smartphone application.

The Mobility Study can be viewed as a precursor to the GPS tracking study proposed within this dissertation. In the Mobility Study, participants indicated that if they were to receive more information regarding certain aspects, they would possibly change their travel behaviour patterns. Therefore if the information types which were found to hold potential for travel behaviour change within the mobility study were incorporated into a TDM measure, the impacts on travel behaviour change regarding the sharing such information could further be analysed.

In this chapter, only certain sections of data collected through the Mobility Study questionnaire are analysed and discussed. Collecting and analysing data relating to transport and activity patterns could assist in formulating a better understanding of why individuals travel the way they do, and what could cause them to alter their travel patterns. If this were the case, the potential impact of information sharing, with emphasis on monetary and environmental costs regarding transport behaviour patterns, could be further elaborated on regarding the population as a whole. Additionally, if it were found that certain subsets of the population were more likely to alter their behaviour due to specific information types, tailored measures could be implemented to maximise the impact of information-driven TDM techniques. Such measures would enable the overall reduction of externalities associated with transport.

This chapter begins with a discussion of the Mobility Study, followed by a discussion of the questionnaire used in the Mobility Study. The dataset regarding the study is then discussed, followed by a section pertaining to the analysis and results, which are then summarised in the conclusion and discussion section of this chapter.

4.2 ANALYSIS OF THE MOBILITY STUDY

As mentioned above, the data analysed in this chapter were acquired from the Mobility Study, which was conducted in 2015 (see Venter, Hitge, Krygsman & Thiart, 2018). This study surveyed students and staff members of Stellenbosch University.

Responses regarding the following aspects were recorded and utilised for the purposes of the Mobility Study: participant demographics, perceptions of private vehicle usage, motivating factors for potentially reducing private vehicle usage, and variables which, according to the participants, inhibit their use of public transport or alternative transport modes.

The individuals who responded to the Mobility Study survey were not presented with any information regarding monetary or environmental costs prior to the completion of the survey. These steps were followed in order to ensure that no bias was formed due to exposure to the prior information, as such exposure may have resulted in altering the perceptions of the individuals and thus skewing potential findings within the dataset.

The main tool used in the analysis of this dataset was regression modelling. This was done in an attempt to derive statistically significant relationships between the various variables regarding participant characteristics and their stated preferences.

4.3 MOBILITY STUDY QUESTIONNAIRE

As stated previously, the data were obtained via a questionnaire-style survey, where participants were invited to take part in the online survey via a link sent through email. The survey had additionally been segregated into various sections. A version of this survey can be found in Addendum J: Stellenbosch University Transport Mobility Study Questionnaire. Data collection took place during the months of September and October of 2015. Students and staff members of Stellenbosch University were given one month to complete the survey.

The first section of the questionnaire related to the demographics of the individuals, and was utilised to understand various characteristics of the respondents. The next section inquired about the individuals' private transport and attempted to gather basic information regarding their everyday

travel patterns. Private vehicle characteristics, as well as responses regarding the individuals' perceptions of their private vehicle, were utilised to investigate the motivations of why participants chose to use their private vehicles instead of other transport modes. Following this, Section 3 investigated public transport and in particular requested participants to indicate their perceptions of public transport and alternative transport modes, while additionally investigating to what extent the respondents had attempted to integrate/incorporate these modes into their own daily lifestyle.

4.4 DATA

The dataset obtained via the questionnaire had been cleaned so that only responses relating to the following question subsets would be used for analysis: demographics, perceptions of private vehicle usage, motivations for potentially reducing private vehicle usage, and variables that inhibit the use of public transport or alternative transport modes.

Once the dataset was cleaned, a total of 853 participant responses were considered for analysis. Of this total, some participants did not fully complete the entire survey; however, the sections they had completed allowed for analysis in at least part of the research and as such were included for the analysis process. Where semi-complete surveys were unable to be analysed due to relevant questions not being answered, these responses were removed from that particular analysis section. The responses were then analysed thoroughly by utilising a combination of Microsoft Excel and IBM's Statistical Package for the Social Sciences (SPSS).

4.5 RESULTS

Of the 853 survey responses collected, 464 were students and the remaining 389 were Stellenbosch University staff members. Demographic statistics of the dataset indicated that of the participants who wished to reveal their gender, 334 were male respondents and 490 were female. Additionally, with regard to individuals who indicated whether they were registered vehicle owners, it was found that 551 were registered vehicle owners and the remaining 139 were not.

Figure 4.1 indicates the frequency distribution of the participants' ages. The age distribution appears to shift significantly to the younger age group, where the majority of responses came from individuals aged between 19 and 25 years old. After this age group, the responses were fairly evenly spread out. The high concentration of younger individuals is due to the questionnaire being circulated to students of Stellenbosch University, who generally tended to be younger than staff members.

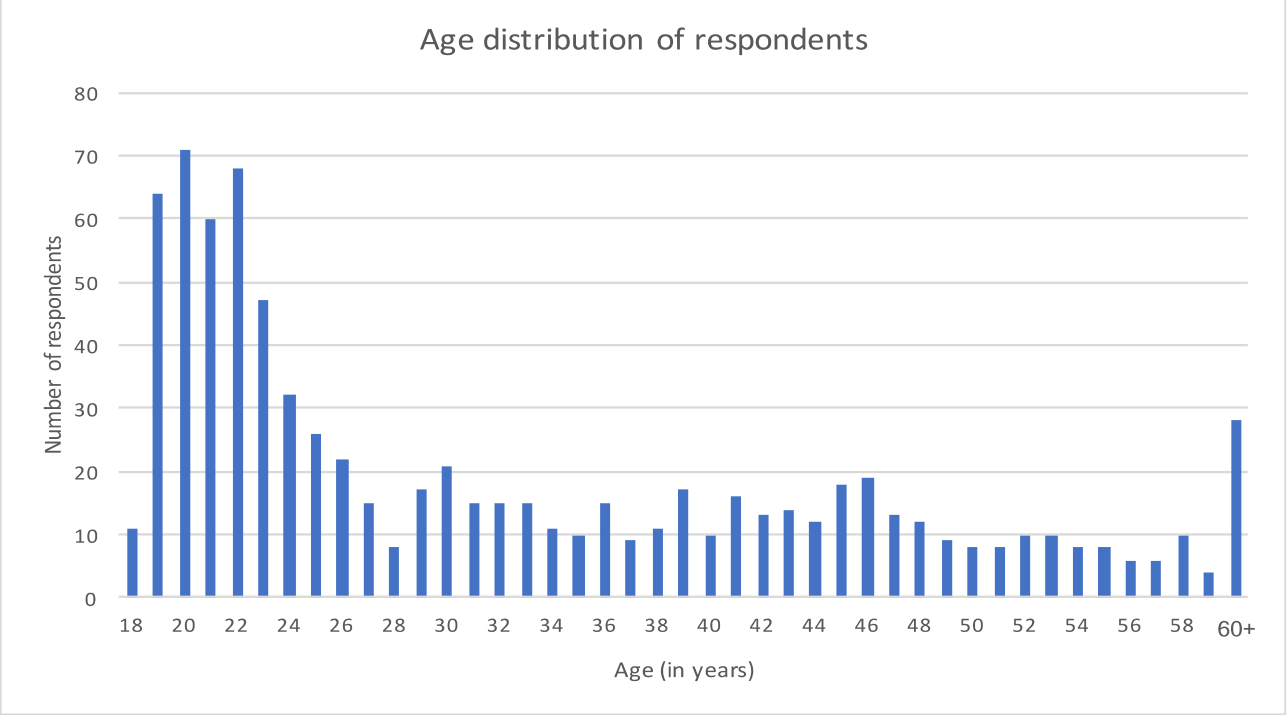

Figure 4.1: Distribution of age of respondents

Source: Compiled by author from Mobility Study data

When investigating the commute distance from campus, the majority of participants were found to commute from within a vicinity of 35 km, with the number of participants reducing as the distance from campus increased. This distribution can be viewed in Figure 4.2.

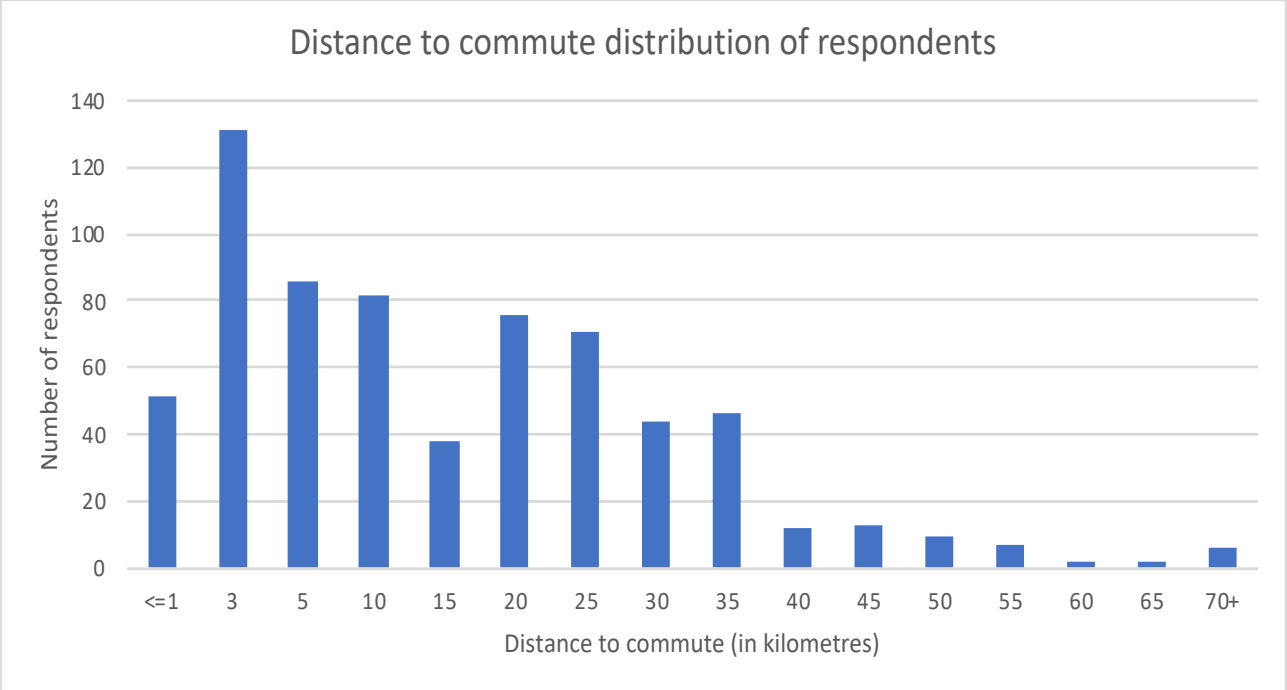

Figure 4.2: Distribution of commute distance for respondents

Source: Compiled by author from Mobility Study data

In order to better understand the split between staff and students with regard to commute distance to campus, further analysis was undertaken. When investigating the average and median values regarding commute distance, it was found that students were more likely to commute shorter distances as on average they commuted 11.27 km to campus (compared to an average of 19 km for staff). The likelihood of students commuting shorter distances was compounded further when investigating the median commute distances, where students were found to have a median commute distance of 4 km (compared to 18 km for staff). The shorter commute distances experienced by students were most likely due to the fact that most student housing within the Stellenbosch University area tends to be on or near campus facilities. Figure 4.3 further illustrates the difference between student and staff commute distances. This figure illustrates that a large contingent of the student respondents commuted from within 3 km or nearer, whereas the largest contingent of the staff respondents commuted between 20 and 25 km when traveling to campus.

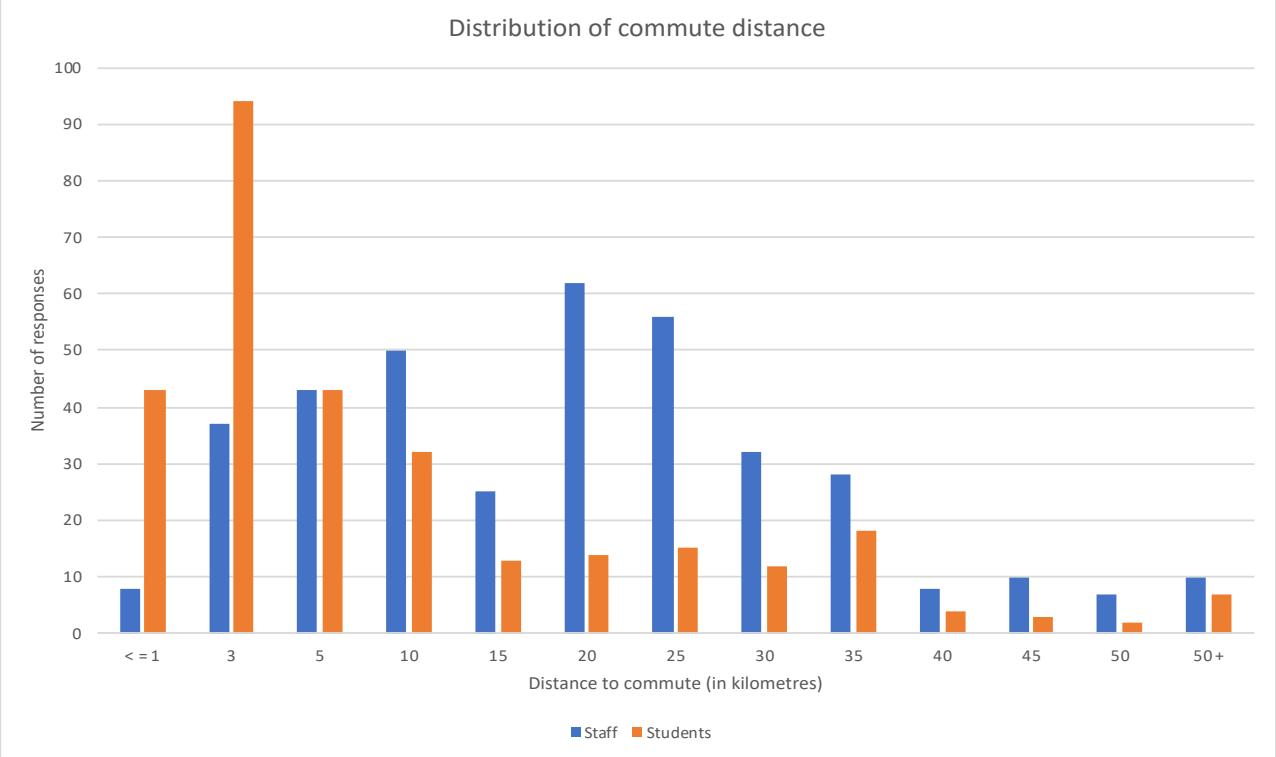

Figure 4.3: Commuting distance of students vs staff

Source: Compiled by author from Mobility Study data

4.5.1 Investigating motives for change

In the survey there were six questions that became the primary focus when attempting to understand what motivating drivers would cause individuals to utilise their private vehicles less. These drivers will later be analysed in an attempt to understand what type of individual (broken down by various demographics) found the various motivating drivers to be most important.

When investigating potential motivations for reducing private vehicle usage, it should be kept in mind that due to not all the questionnaires being answered completely, the number of responses per variable varied. Table 4.1 indicates the total number of responses per variable when investigating what motivations may lead participants to reduce their private vehicle usage. The ranking scale used for these "motivators" ranged from 1-5, where 1 = a strong willingness to reduce private vehicle usage due to the respective variable, and 5 = no willingness to reduce private vehicle usage. The variables investigated with regard to reducing private vehicle usage included a reduction in carbon emissions, more alternatives becoming available, a reduction in parking availability, increased parking charges, avoidance of congestion, and reduced monthly expenses.

Table 4.1: Breakdown of responses in terms of motivations for reducing private vehicle use

		Motivation to reduce private vehicle usage					
		Reduced Carbon Emissions	More Alternatives Available	Reduction in Parking Availability	Increase in Parking Costs	Congestion Aversion	Reduction in Overall Transport Costs
Indicated Rank	1	152 (28%)	272 (50%)	104 (19%)	116 (22%)	190 (35%)	240 (44%)
	2	109 (20%)	111 (20%)	93 (17%)	89 (17%)	95 (17%)	105 (19%)
	3	132 (24%)	62 (11%)	129 (24%)	123 (23%)	112 (21%)	90 (16%)
	4	72 (13%)	51 (9%)	98 (18%)	92 (18%)	74 (14%)	65 (12%)
	5	81 (15%)	50 (9%)	110 (21%)	105 (20%)	72 (13%)	47 (9%)
	Total	546 (100%)	546 (100%)	534 (100%)	525 (100%)	543 (100%)	547 (100%)

Source: Compiled by author from Mobility Study data

Table 4.1 indicates that the variable that received the greatest number of responses was the variable where participants were asked whether a reduction in overall transport costs would encourage reduced private vehicle usage, with 547 recorded responses. A total of 44% (240) of these participants indicated that a reduction in transport costs was a strong motivator when investigating motives for reducing private vehicle usage. Another noteworthy variable when investigating potential motives for participants to reduce private vehicle usage was identified as "a greater number of available alternatives". Here, 50% (272) of the participants indicated that a greater number of alternatives would strongly motivate them to utilise their private vehicles less. The least motivating variables to reduce private vehicle usage were found to be a reduction in parking availability and an increase in parking costs, where 19% and 22% of respondents respectively indicated that these variables strongly motivated them to reduce private vehicle usage. This could potentially be due to participants believing that they would be able to find alternative places to park, which would not drastically impact their decision-making process.

The independent variables investigated when attempting to create relationships relating to the motivating drivers, as mentioned above, were participant demographics, namely the gender of the participant, the age of the participant, whether the participant was a student or staff member, their level of education, employment status, whether they were registered vehicle owners, and what their average commute distance to campus was. Given that all the independent variables besides commute

distance and age level were categorical, these two variables were divided into quartile categories in order to assist in analysis. The quartiles for commute distance and age are presented in Table 4.2.

Table 4.2: Breakdown of age and commute distance quartiles

Age of participant			Commute distance to campus		
Quartile	**Result**	**Note**	**Quartile**	**Result**	**Note**
0	18	Min. value	0	0.1	Min. value
1	21.25	25th percentile	1	3	25th percentile
2	27	50th percentile	2	10	50th percentile
3	42	75th percentile	3	25	75th percentile
4	78	Max. value	4	200	Max. value

Source: Compiled by author from Mobility Study data

4.5.1.1 Willingness to change for environmental factors

The first in a series of regression analysis tests that were investigated was the willingness to reduce private vehicle usage in order to reduce impacts on the environment. From the cleaned data subset, it was found that 546 responses were useable and of these 322 were women, with the remainder being men (224), with 328 being staff members and 218 being students. The responses indicating the importance of the motivating driver (dependent variable) ranged from values of 1-5, had a median value of 3, and an average value of 2.671. Table 4.3 presents the summary output and the analysis of variance (ANOVA) table with regard to the regression analysis.

Table 4.3: Regression outputs for willingness to change to reduce environment impact

Regression Statistics	
Multiple R	0.19556174
R-Square	0.03824439
Adjusted R-Square	0.02573085
Standard Error	1.37286173
Observations	546

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	40.32170969	5.76024424	3.05623891	0.003658854
Residual	538	1013.99514	1.88474933		
Total	545	1054.31685			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3.26304663	0.355085021	9.18947979	8.5527E-19	2.565523584	3.96056967	2.56552358	3.96056967
AGE Q	-0.3237147	0.099066144	-3.2676622	0.00115359	-0.518318563	-0.1291108	-0.5183186	-0.1291108
DIST Q	-0.0360318	0.059371647	-0.6068848	0.54418336	-0.152660416	0.08059691	-0.1526604	0.08059691
Stu0Sta1	0.20709165	0.220153644	0.94066873	0.34729681	-0.225374466	0.63955776	-0.2253745	0.63955776
M0F1	-0.2414488	0.124131591	-1.9451035	0.05228311	-0.485290804	0.00239321	-0.4852908	0.00239321
Edu	0.04800816	0.037479875	1.28090492	0.20077894	-0.025616679	0.12163299	-0.0256167	0.12163299
Empl	-0.0215327	0.042153316	-0.5108196	0.60968691	-0.104338006	0.06127252	-0.104338	0.06127252
Own1NO0	0.1614749	0.206456865	0.78212415	0.4344857	-0.244085493	0.56703529	-0.2440855	0.56703529

Source: Compiled by author from Mobility Study data

Table 4.3 shows that only 3.8% of the variation can be explained by this regression, as revealed by the R-squared value. The significance associated with the p-value for this regression is 0.0036,

illustrated by the Significance F-value, which indicates that the logistic regression holds some significance in illustrating a relationship between the dependent and independent variables.

Coefficient values relating to the independent variables illustrate the relationship regarding the independent variables to the dependent variable, where negative values indicate an inverse relationship and larger values indicate the magnitude of the relationship. For example, when investigating the relationship between the likelihood of a participant being willing to reduce their private vehicle usage in order to reduce their carbon emissions with regard to the age of the participant, due to the Age Quartile coefficient value being -0.32, it can be deduced that as age increases, the importance of reducing private vehicle usage to reduce carbon emissions also increases. This is due to the scale for the dependent variable remaining the same, and therefore as the dependent variable decreases, the importance of the motivation to reduce private vehicle usage increases. Therefore, any negative coefficient with regard to the independent variables indicates that as the independent variable increases, an increased importance in willingness to reduce private vehicle usage decreases, and vice versa.

When investigating the independent variables on their own, it is seen that of the seven investigated, only two – age and gender (with gender being borderline significant) – appear to be statistically significant (indicated by the corresponding p-values being less than or near to 0.05) with regard to willingness to reduce private vehicle usage in order to decrease the impact on the environment.

Table 4.4 reveals the results from a second regression analysis using only the independent variables of ages (in quartiles) and gender (with values of 0 for men and 1 for women) when investigating their relationship with the dependent variable of willingness to reduce private vehicle usage to reduce carbon emissions.

Table 4.4: Further refined regression outputs for willingness to change to reduce environmental impact

Regression Statistics	
Multiple R	0.17617243
R-Square	0.03103672
Adjusted R-Square	0.0274678
Standard Error	1.3716374
Observations	546

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	32.72254175	16.3612709	8.69637782	0.000191618
Residual	543	1021.594308	1.88138915		
Total	545	1054.31685			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3.40230809	0.185273259	18.3637299	6.0556E-59	3.038367976	3.76624821	3.03836798	3.76624821
AGE Q	-0.2075149	0.057184388	-3.6288739	0.00031155	-0.31984466	-0.0951852	-0.3198447	-0.0951852
M0F1	-0.2494653	0.120244698	-2.0746471	0.03848972	-0.48566708	-0.0132636	-0.4856671	-0.0132636

Source: Compiled by author from Mobility Study data

Once again, the overall regression is shown to hold statistical significance, as illustrated by the Significance-F of 0.00019 (due to it being less than 0.05). However, the variations of this model are less explained as the R-squared value now illustrates that 3.1% of the outcomes are explained. The two independent variables within this model remain statistically significant, due to their respective p-values. The negative coefficients indicate that women (compared to men) and older respondents were generally more willing to reduce private vehicle usage in order to reduce their impacts on the environment. A potential reason for this could be due to women and older individuals in general being more socially aware of the impacts that carbon emissions have on the environment and society as a whole, and they are therefore willing to reduce their private vehicle usage if they were to be rewarded by fewer carbon emissions.

4.5.1.2 Willingness to reduce vehicle usage if alternatives become available

In the following model, the same independent variables were used. The dependent variable in this analysis is the willingness to reduce vehicle usage if alternatives become available.

Once incomplete responses were removed, a total of 546 responses were analysed. The dependent variable ranged from values of 1-5, with a median value of 2 and an average value of 2.0769. Table 4.5 presents the outputs of the regression analysis.

Table 4.5: Regression outputs for willingness to reduce vehicle usage if alternatives become available

Regression Statistics	
Multiple R	0.11425963
R-Square	0.01305526
Adjusted R-Square	0.00021397
Standard Error	1.34407194
Observations	546

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	12.8564204	1.83663149	1.01666294	0.41826024
Residual	538	971.9128104	1.80652939		
Total	545	984.7692308			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.29806841	0.31104592	7.3881966	5.7149E-13	1.68705504	2.90908178	1.68705504	2.90908178
Age Q	-0.1045647	0.0972206	-1.0755406	0.28261485	-0.2955432	0.08641381	-0.2955432	0.08641381
Dist Q	0.01090458	0.057720166	0.18892156	0.85022554	-0.1024799	0.12428911	-0.1024799	0.12428911
Stu0Sta1	-0.0850118	0.214523335	-0.3962823	0.6920539	-0.5064178	0.33639423	-0.5064178	0.33639423
M0F1	-0.041992	0.121283275	-0.3462305	0.72930482	-0.2802388	0.19625485	-0.2802388	0.19625485
Edu	-0.0180146	0.036934045	-0.4877503	0.62592543	-0.0905672	0.05453803	-0.0905672	0.05453803
Empl	0.02035514	0.039449887	0.51597449	0.60608421	-0.0571396	0.09784983	-0.0571396	0.09784983
Own1NO0	0.23200776	0.18220734	1.2733173	0.20345536	-0.1259173	0.58993279	-0.1259173	0.58993279

Source: Compiled by author from Mobility Study data

Table 4.5 indicates that only 1.3% of the variation can be explained by this regression, as revealed by the R-squared value. The significance associated with the p-value for this regression is 0.418, illustrated by the Significance F-value. This indicates that the logistic regression holds no statistical significance in illustrating a relationship between the dependent and independent variables.

When investigating the statistical significance of the independent variable individually, none were found to hold statistical significance (as all relative p-values were greater than 0.05). Therefore, this regression model can be determined as a very poor fit and no further analysis was performed regarding the willingness to reduce vehicle usage if alternatives become available.

4.5.1.3 Willingness to reduce vehicle usage if parking availability reduces

In the following analysis, the same independent variables were used as before. The dependent variable in this analysis is the willingness to reduce vehicle usage if parking becomes less available.

Once incomplete responses were removed, a total of 534 responses were utilised for this analysis. The dependent variable ranged from values of 1-5, had a median value of 3, and an average value of 3.0318. Table 4.6 indicates the outputs of this regression analysis.

Table 4.6: Regression output for willingness to reduce private vehicle usage if parking becomes less available

Regression Statistics	
Multiple R	0.22469568
R-Square	0.05048815
Adjusted R-Square	0.03785206
Standard Error	1.3744166
Observations	534

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	52.83376697	7.547681	3.99555171	0.00028473
Residual	526	993.6250345	1.88902098		
Total	533	1046.458801			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.05785942	0.323200031	6.36713869	4.2009E-10	1.42293806	2.69278078	1.42293806	2.69278078
Age Q	-0.0196584	0.100364248	-0.195871	0.84478679	-0.2168224	0.17750554	-0.2168224	0.17750554
Dist Q	0.08129712	0.059583131	1.3644318	0.17301515	-0.035753	0.19834724	-0.035753	0.19834724
Stu0Sta1	-0.3283964	0.223176095	-1.4714676	0.14176272	-0.7668223	0.11002954	-0.7668223	0.11002954
M0F1	-0.1130723	0.12519557	-0.9031651	0.36685168	-0.359017	0.13287245	-0.359017	0.13287245
Edu	0.05621681	0.038359056	1.46554201	0.14337059	-0.019139	0.13157257	-0.019139	0.13157257
Empl	0.17786393	0.043644045	4.07533088	5.3046E-05	0.09212589	0.26360196	0.09212589	0.26360196
Own1NO0	0.46701201	0.187271143	2.49377454	0.01294532	0.0991208	0.83490321	0.0991208	0.83490321

Source: Compiled by author from Mobility Study data

Table 4.6 shows that only approximately 5% of the variation can be explained by this regression, illustrated by the R-squared value. The significance associated with the p-value for this regression is 0.00028, illustrated by the Significance F-value. This indicates that the regression model holds some statistical significance in illustrating a relationship between the dependent and independent variables. When investigating the independent variables, it can be seen that of the seven independent variables, only two appear to be statistically significant, i.e. the level of employment and whether the participants were registered vehicle owners or not.

The relationships regarding these two variables indicate that as employment level (employment seniority) increases, the willingness to reduce private vehicle usage due to a reduction in parking availability decreases. In other words, the more senior an employee, the less concerned they appear

to be regarding the availability of parking spaces. This could potentially be due to senior staff being viewed as of greater importance and thus if parking spaces are reduced, they would be the least likely to have their designated parking spots taken away. Investigating the relationship between registered vehicle owners and non-registered vehicle users reveals that registered vehicle owners are less inclined to reduce their vehicle usage if parking availability were to be reduced.

A second regression analysis was performed utilising only the employment and registered owner variables as independent variables, as well as the dependent variable of willingness to reduce vehicle usage if parking becomes less available. Table 4.7 displays the results from this second regression analysis.

Table 4.7: Further refined regression for willingness to reduce private vehicle usage if parking becomes less available

Regression Statistics	
Multiple R	0.12885009
R-Square	0.01660235
Adjusted R-Square	0.0128984
Standard Error	1.39212551
Observations	534

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	17.37367099	8.6868355	4.4823402	0.011738
Residual	531	1029.085131	1.93801343		
Total	533	1046.458801			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.48451246	0.23831192	10.4254645	2.8042E-23	2.01636262	2.9526623	2.01636262	2.9526623
Empl	0.01810459	0.031666431	0.57172806	0.56774815	-0.0441023	0.08031144	-0.0441023	0.08031144
Own1NO0	0.49366121	0.18161425	2.71818544	0.00677866	0.13689063	0.85043179	0.13689063	0.85043179

Source: Compiled by author from Mobility Study data

Once again, the overall regression is shown to hold statistical significance, as illustrated by the Significance F-value of 0.017. However, the variations of this model are less explained as the R-squared value now illustrates that 1.66% of the outcomes are explained. Of the two independent variables within this model, only one (whether the respondent was a registered vehicle owner) remains statistically significant, as indicated by its p-value. The positive coefficient indicates that, generally, respondents who were not registered vehicle owners would be more willing to reduce private vehicle usage if parking became less available.

This finding could potentially be explained due to the non-registered vehicle owners feeling less "tied" to the vehicle that they utilise because it is not registered in their name. Due to this, it could be reasoned that for these individuals it would be easier to disassociate themselves from the vehicle and reduce their utilisation of it if parking availability were reduced than if they were the registered vehicle owner.

4.5.1.4 Willingness to reduce vehicle usage if parking became more expensive

In the following analysis, the same independent variables were used as before. The dependent variable in this analysis is the willingness to reduce vehicle usage if parking became more expensive.

Once incomplete responses were removed, a total of 525 responses were utilised for this analysis. The dependent variable ranged from values of 1-5, had a median value of 3, and an average value of 2.9638. Table 4.8 presents the outputs of the regression analysis.

Table 4.8: Regression output for willingness to reduce private vehicle usage if parking becomes more expensive

Regression Statistics	
Multiple R	0.20874153
R-Square	0.04357303
Adjusted R-Square	0.03062334
Standard Error	1.40318584
Observations	525

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	46.37531348	6.62504478	3.36479362	0.00160917
Residual	517	1017.937067	1.9689305		
Total	524	1064.312381			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.13613508	0.332928463	6.41619843	3.1608E-10	1.48207611	2.79019405	1.48207611	2.79019405
Age Q	0.00066924	0.103363918	0.00647457	0.99483658	-0.2023957	0.20373418	-0.2023957	0.20373418
Dist Q	0.09511385	0.061723268	1.54097238	0.12393533	-0.0261454	0.2163731	-0.0261454	0.2163731
Stu0Sta1	-0.2735223	0.228727702	-1.1958424	0.23230623	-0.7228723	0.17582771	-0.7228723	0.17582771
M0F1	-0.2352782	0.128693743	-1.8282026	0.06809522	-0.4881052	0.01754875	-0.4881052	0.01754875
Edu	0.04521857	0.039181538	1.15407852	0.24900118	-0.031756	0.12219318	-0.031756	0.12219318
Empl	0.16156605	0.045210018	3.57367812	0.00038496	0.07274812	0.25038398	0.07274812	0.25038398
Own1NO0	0.35765895	0.193769631	1.84579467	0.06549355	-0.0230137	0.73833162	-0.0230137	0.73833162

Source: Compiled by author from Mobility Study data

Table 4.8 shows that only about 4.4% of the variation can be explained by this regression, illustrated by the R-squared value. The significance associated with the p-value for this regression is 0.0016, illustrated by the Significance F-value. This indicates that the regression model holds some statistical significance in illustrating a relationship between the dependent and independent variables. When investigating the independent variables, it can be seen that of the seven independent variables, only one appears to be statistically significant, namely the participants' level of employment. The relationship indicates that junior employees appeared to be more concerned about the price of parking, as illustrated by the coefficient that indicates that willingness to reduce vehicle usage is less likely to occur as employment level (seniority) increases. This could be due to the fact that junior staff earn less than senior staff and are therefore more price sensitive, which would cause them to be more willing to reduce vehicle usage if parking charges increased.

A second regression analysis was performed utilising only the participant employment level as an independent variable, and the dependent variable of willingness to reduce vehicle usage if parking charges increased. Table 4.9 displays the results from this second regression analysis.

Table 4.9: Further refined regression analysis of willingness to reduce private vehicle usage if parking expenses increased

Regression Statistics	
Multiple R	0.15052172
R-Square	0.02265679
Adjusted R-Square	0.02078806
Standard Error	1.41028622
Observations	525

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	24.11389869	24.1138987	12.1241948	0.00053937
Residual	523	1040.198482	1.98890723		
Total	524	1064.312381			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.71748548	0.093770436	28.9801945	7.533E-111	2.5332725	2.90169846	2.5332725	2.90169846
Empl	0.14289516	0.041038461	3.48198145	0.00053937	0.06227468	0.22351564	0.06227468	0.22351564

Source: Compiled by author from Mobility Study data

Once again, the overall regression is shown to hold statistical significance, as illustrated by the Significance F-value of 0.0005. However, the variations of this model are less explained as the R-squared value now illustrates that 2.3% of the outcomes are explained. The single independent variable within this model (categorised level of employment) remains statistically significant, as indicated by the respective p-value. The positive coefficient indicates that, generally, junior employees would be more willing to reduce private vehicle usage if parking became more expensive. The potential reasoning for this was discussed above.

4.5.1.5 Willingness to reduce vehicle usage if congestion would be avoided

In the following analysis, the same independent variables were used as before. The dependent variable in this analysis is the willingness to reduce vehicle usage in order to avoid congestion.

Once incomplete responses were removed, a total of 543 responses were utilised for this analysis. The dependent variable ranged from values of 1-5, had a median value of 2, and an average value of 2.526. Table 4.10 shows the outputs of the regression analysis.

Table 4.10: Regression output for willingness to reduce private vehicle usage in order to avoid congestion

Regression Statistics	
Multiple R	0.16871492
R-Square	0.02846472
Adjusted R-Square	0.01575305
Standard Error	1.41036457
Observations	543

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	31.1791984	4.4541712	2.23925795	0.02986634
Residual	535	1064.1836	1.98912823		
Total	542	1095.3628			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.33123327	0.32733786	7.12179534	3.4532E-12	1.68820815	2.97425839	1.68820815	2.97425839
Age Q	-0.126981	0.10351419	-1.2267014	0.22047442	-0.3303251	0.0763631	-0.3303251	0.0763631
Dist Q	0.00773327	0.06089611	0.12699116	0.89899511	-0.1118915	0.12735808	-0.1118915	0.12735808
Stu0Sta1	-0.0510041	0.22708398	-0.2246046	0.82237264	-0.4970897	0.39508149	-0.4970897	0.39508149
M0F1	0.02146968	0.1272291	0.16874817	0.86605851	-0.2284602	0.27139955	-0.2284602	0.27139955
Edu	0.00027994	0.038722	0.00722956	0.99423439	-0.0757859	0.07634575	-0.0757859	0.07634575
Empl	-0.0284735	0.04251938	-0.6696583	0.50336453	-0.1119989	0.05505195	-0.1119989	0.05505195
Own1NO0	0.68451113	0.19197003	3.56571863	0.00039538	0.30740365	1.0616186	0.30740365	1.0616186

Source: Compiled by author from Mobility Study data

Table 4.10 indicates that only 2.8% of the variation can be explained by this regression, illustrated by the R-squared value. The significance associated with the p-value for this regression is 0.029, illustrated by the Significance F-value. This indicates that the logistic regression holds some statistical significance in illustrating a relationship between the dependent and independent variables. When investigating the independent variables, it can be seen that of the seven independent variables, only one appears to be statistically significant, namely whether the participants were registered vehicle owners or not. The relationship indicates that registered vehicle owners are less inclined to reduce vehicle usage in order to avoid congestion. In other words, non-registered vehicle owners are more likely to reduce private vehicle usage so that congestion can be avoided.

A second regression analysis was performed utilising only the registered owner variable as an independent variable, with the dependent variable being willingness to reduce vehicle usage in order to avoid congestion. Table 4.11 illustrates the results from this second regression analysis.

Table 4.11: Further refined regression for willingness to reduce private vehicle usage to avoid congestion

Regression Statistics	
Multiple R	0.12587487
R-Square	0.01584448
Adjusted R-Square	0.01402534
Standard Error	1.41160188
Observations	543

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	17.3554567	17.3554567	8.7098684	0.00330213
Residual	541	1078.00734	1.99261986		
Total	542	1095.3628			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.06944444	0.16635888	12.4396395	2.0229E-31	1.74265595	2.39623294	1.74265595	2.39623294
Own1NO0	0.52715853	0.1786222	2.95124862	0.00330213	0.17628047	0.87803659	0.17628047	0.87803659

Source: Compiled by author from Mobility Study data

Once again, the overall regression is shown to hold statistical significance, as illustrated by the Significance F-value of 0.0033. However, the variations of this model are less explained as the R-squared value now illustrates that 1.6% of the outcomes are explained. The single independent variable within this model (whether the respondent was a registered vehicle owner or not) remains statistically significant, as indicated by the respective p-value. The positive coefficient indicates that, generally, respondents who were registered vehicle owners would be less willing to reduce private vehicle usage in order to avoid congestion. A possible reason for this finding could be that registered vehicle owners perceive the advantages of being a registered vehicle owner as greater than the inconveniences experienced by congestion and thus would be less likely to use their vehicles less in order to avoid the congestion.

4.5.1.6 Willingness to reduce vehicle usage in order to reduce costs

In the following analysis, the same independent variables were used as before. The dependent variable in this analysis is the willingness to reduce vehicle usage in order to reduce costs.

Once incomplete responses were removed, a total of 547 responses were utilised for this analysis. The dependent variable ranged from values of 1-5, had a median value of 2, and an average value of 2.2212. Table 4.12 presents the outputs of the regression analysis.

Table 4.12: Regression outputs for willingness to reduce private vehicle usage in order to reduce transport costs

Regression Statistics	
Multiple R	0.19157741
R-Square	0.0367019
Adjusted R-Square	0.02419154
Standard Error	1.32762663
Observations	547

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	36.1966646	5.17095208	2.93371961	0.00505909
Residual	539	950.037339	1.76259247		
Total	546	986.234004			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.18230833	0.30796935	7.0861219	4.3371E-12	1.57734106	2.78727561	1.57734106	2.78727561
Age Q	-0.0655896	0.09514435	-0.689369	0.49088775	-0.2524887	0.12130962	-0.2524887	0.12130962
Dist Q	-0.0867399	0.05717244	-1.5171635	0.12981167	-0.1990481	0.02556817	-0.1990481	0.02556817
Stu0Sta1	-0.1826477	0.21217483	-0.8608359	0.38971119	-0.5994386	0.23414321	-0.5994386	0.23414321
M0F1	-0.1785252	0.11942134	-1.4949186	0.1355209	-0.4131135	0.05606311	-0.4131135	0.05606311
Edu	0.01893451	0.03554248	0.53272902	0.59444073	-0.0508843	0.08875327	-0.0508843	0.08875327
Empl	0.00196997	0.03889547	0.05064792	0.95962484	-0.0744353	0.07837526	-0.0744353	0.07837526
Own1NO0	0.61668998	0.17910434	3.44318829	0.00061959	0.26486189	0.96851807	0.26486189	0.96851807

Source: Compiled by author from Mobility Study data

Table 4.12 indicates that only 3.7% of the variation can be explained by this regression, illustrated by the R-squared value. The significance associated with the p-value for this regression is 0.005, illustrated by the Significance F-value. This indicates that the logistic regression holds some statistical significance in illustrating a relationship between the dependent and independent variables. When

investigating the independent variables individually, it can be seen that of the seven independent variables, only one appears to be statistically significant, namely whether the participants were registered vehicle owners or not. The relationship indicates once again that registered vehicle owners are less inclined to reduce vehicle usage in order to reduce costs.

A second regression analysis was performed utilising only the registered owner variable as an independent variable, and the dependent variable being willingness to reduce vehicle usage in order to reduce costs. Table 4.13 shows the results from the second regression analysis.

Table 4.13: Further refined regression analysis for willingness to reduce private vehicle usage in order to reduce transportation costs

Regression Statistics	
Multiple R	0.12070152
R-Square	0.01456886
Adjusted R-Square	0.01276073
Standard Error	1.33538003
Observations	547

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	14.3683023	14.3683023	8.05741443	0.00470076
Residual	545	971.865701	1.78323982		
Total	546	986.234004			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.80821918	0.15629441	11.5693144	7.8126E-28	1.50120596	2.1152324	1.50120596	2.1152324
Own1NO0	0.47659095	0.16789893	2.83855851	0.00470076	0.14678266	0.80639924	0.14678266	0.80639924

Source: Compiled by author from Mobility Study data

Once again, the overall regression is shown to hold statistical significance, as illustrated by the Significance F-value of 0.0047. However, the variations of this model are less explained as the R-squared value now illustrates that 1.5% of the outcomes are explained. The single independent variable within this model (whether the respondent was a registered vehicle owner or not) remains statistically significant, as indicated by the respective p-value. The positive coefficient indicates that, generally, respondents who were registered vehicle owners would be less willing to reduce private vehicle usage in order to reduce transportation costs. A potential reason for this is that registered vehicle owners may perceive that the majority of the costs experienced are “sunk costs” (costs incurred in purchasing the vehicle). Due to this perception, vehicle owners may believe that the cost of utilising the vehicle is relative marginal. Another potential reason could be, as mentioned previously, that the registered vehicle owners perceive the convenience of using their own vehicles as greater than the potential savings they could experience by utilising their vehicle less or switching to alternative modes.

4.6 SUMMARY OF FINDINGS

In the previous discussion it was found that, overall, none of the regression models were able to explain an appropriately significant amount of the outcomes; the greatest R-square value that indicated that only 5% of the regression outcomes could be explained was found in Table 4.6. Some of the models that were found to have statistical significance, and independent variables that indicated a statistically significant relationship toward the dependent variable, were then further analysed in another regression analysis, where non-significant variables were removed.

Further investigation into these additional regression models showed that, generally speaking, older respondents were more willing to reduce private vehicle usage in order to reduce their impact on the environment. Women were also more willing to reduce private vehicle usage in order to reduce their impact on the environment when compared to men. As mentioned previously, this could be due to women and older individuals in general being more socially aware of the impacts that carbon emissions have on the environment and society as a whole, and they are therefore willing to reduce their private vehicle usage if they were to be rewarded by fewer carbon emissions.

With regard to the investigation of employment status, junior employees were found to be more willing to reduce private vehicle usage if parking costs were to increase. This greater level of price sensitivity among less senior employees could be attributed to the fact that these employees earn less than their more senior colleagues and increases in parking charges would therefore have a greater relative impact on their disposable income. This increased price sensitivity would therefore encourage more junior employees to alter their private vehicle usage if parking charges increased.

Respondents who indicated that they were not registered vehicle owners were found to be more willing to reduce private vehicle usage with regard to three different motivators. These motivators include the reduction of parking availability, the potential to avoid congestion, and an increase in costs. It can be assumed that due to not being the registered owners of the private vehicles they use, these individuals would be less attached to the vehicles. This finding is corroborated by research undertaken by Cullinane and Cullinane (2003), where it was found that once people acquire a private vehicle, their perception leads them to believe that the vehicle must become a necessary part of their lifestyle. Therefore, non-registered vehicle owners appear to be more flexible when investigating their willingness to alter their travel behaviour patterns in order to avoid any increase in inconvenience or costs.

In summary, even though the regression models failed to explain a significant proportion of outcomes (R-square values), due to the models still holding statistical significance, certain segments of the population can potentially be highlighted as being more willing to reduce private vehicle usage when

exposed to certain informational- or educational-based TDM measures. With regard to environmental information, it is recommended that women and older individuals be the selected target market for the informational measure. Monetary cost informational measures may be more influential to individuals who are younger, as they tend to be lower-income earners and are therefore more price sensitive, as well as to those who are not registered vehicle owners. Finally, it was also found that non-registered vehicle owners may also be more inclined to reduce vehicle usage if information regarding reduction in parking availability or congestion decrease were to be shared with them.

It should be noted that further analysis and research regarding the willingness to reduce private vehicle usage are recommended. As previously mentioned, even though some of the regression models hold statistical significance, the overall values within these models are far from satisfactory. Due to this, any findings and statements regarding subgroups of the population should be taken lightly and are only applicable to the relative sample group that responded to the Mobility Study.

CHAPTER 5:
DATA ANALYSIS AND FINDINGS

5.1 INTRODUCTION

This chapter emphasises the analysis of demographic, socio-economic, and travel behaviour data gathered using the questionnaires and GPS tracking devices. To begin, the responses collected from the first questionnaire (see Addendum C: First Questionnaire) are analysed, with emphasis on the difference in responses pertaining to various demographics from within the participant sample group. Following this, an investigation into the differences in responses from before and after the research exercise is made; by comparing the responses from the first questionnaire to those to the second questionnaire (see Addendum F: Second Questionnaire).

Next, average travel behaviour pertaining to demographics and vehicle characteristics are analysed. The penultimate section of this chapter includes an investigation into the participant travel behaviour patterns illustrated during the four-week research exercise period, and the chapter concludes with a short summary of findings.

Seeing as the analysis of the Mobility Study failed to explain whether certain segments of the population were found to be more willing to reduce their private vehicle usage when responding to various factors that may encourage them to do, when investigating into whether participants altered their travel behaviour patterns, any change in travel behaviour, during the four-week GPS tracking period, was analysed for the group as a whole with no further segregation of participants.

5.2 ANALYSIS OF THE FIRST QUESTIONNAIRE

Table 5.1 displays the extracted and categorised data derived from the first questionnaire (see Addendum C: First Questionnaire). It should be noted that any participant identifiers were removed to maintain the confidentiality of participants and that the responses were separated into various demographic groupings in order to assist in the analysis. The separation into demographic groupings was performed in the hope of better understanding whether certain types of responses are more or less likely to fall into certain groupings.

It should be noted that the total sample size for this research study was 23 participants, and that due to the relatively low number of total participants, any identified differences cannot be proven to be statistically significant for the population as a whole, and are therefore used as an illustrative means to encourage further discussion.

Table 5.1: Questionnaire 1: Descriptive results

Columns	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
ALL PARTICIPANTS	Number	Est. km/week	Est. cost/week	Est. cost/km	Monetary	Time	Other	Pvt. essential	Pvt. safe	No alts	Convenient	Quickness	Cheapness	Reduce CO_2	More alts	Reduce cong.	Reduce cost
Overall	23	308.26	R 587.13	R 1.90	6.00	5.26	4.96	3.04	3.78	3.70	4.35	4.30	2.48	3.17	3.96	3.83	3.83
GENDER	Number	Est. km/week	Est. cost/week	Est. cost/km	Monetary	Time	Other	Pvt. essential	Pvt. safe	No alts	Convenient	Quickness	Cheapness	Reduce CO_2	More alts	Reduce cong.	Reduce cost
Man	12	329.17	R 750.00	R 2.28	6.00	4.75	4.75	3.08	3.92	4.17	4.33	4.25	2.50	3.33	4.00	4.00	3.83
Woman	11	285.45	R 409.45	R 1.43	6.00	5.82	5.18	3.00	3.64	3.18	4.36	4.36	2.45	3.00	3.91	3.64	3.82
AGE	Number	Est. km/week	Est. cost/week	Est. cost/km	Monetary	Time	Other	Pvt. essential	Pvt. safe	No alts	Convenient	Quickness	Cheapness	Reduce CO_2	More alts	Reduce cong.	Reduce cost
Under 40	9	260.00	R 483.33	R 1.86	6.78	4.22	4.67	3.56	3.89	3.89	4.78	4.67	2.22	2.56	4.00	3.89	4.33
40 or older	14	339.29	R 653.86	R 1.93	5.50	5.93	5.14	2.71	3.71	3.57	4.07	4.07	2.64	3.57	3.93	3.79	3.50
DRIVE OFTEN	Number	Est. km/week	Est. cost/week	Est. cost/km	Monetary	Time	Other	Pvt. essential	Pvt. safe	No alts	Convenient	Quickness	Cheapness	Reduce CO_2	More alts	Reduce cong.	Reduce cost
4 days or less	7	301.43	R 785.71	R 2.61	5.43	6.57	5.29	3.14	3.14	3.71	4.00	3.71	2.71	2.86	4.43	3.86	3.43
5 or more days	16	311.25	R 500.25	R 1.61	6.25	4.69	4.81	3.00	4.06	3.69	4.50	4.56	2.38	3.31	3.75	3.81	4.00
CARPOOL	Number	Est. km/week	Est. cost/week	Est. cost/km	Monetary	Time	Other	Pvt. essential	Pvt. safe	No alts	Convenient	Quickness	Cheapness	Reduce CO_2	More alts	Reduce cong.	Reduce cost
Yes	6	313.33	R 508.33	R 1.62	5.50	5.17	4.17	4.33	4.50	2.33	4.50	4.83	2.17	3.33	2.83	3.50	3.83
No	17	306.47	R 614.94	R 2.01	6.18	5.29	5.24	2.59	3.53	4.18	4.29	4.12	2.59	3.12	4.35	3.94	3.82
DROP OFF	Number	Est. km/week	Est. cost/week	Est. cost/km	Monetary	Time	Other	Pvt. essential	Pvt. safe	No alts	Convenient	Quickness	Cheapness	Reduce CO_2	More alts	Reduce cong.	Reduce cost
Yes	6	218.33	R 460.67	R 2.11	5.50	3.67	3.17	2.50	3.50	4.33	4.50	4.50	2.33	3.33	3.50	3.33	3.83
No	17	340.00	R 631.76	R 1.86	6.18	5.82	5.59	3.24	3.88	3.47	4.29	4.24	2.53	3.12	4.12	4.00	3.82

In Table 5.1, as mentioned above, participants were separated into various categories, and these categories were broken down into rows. The first row of Table 5.1 reveals the overall averages for the group of 23 participants. This is used as a comparison point for investigating any noticeable differences that may occur across various segmented groupings. The first segmentation was by gender, where in this sample group 12 men and 11 women were present. The next segmentation was performed regarding participant age. To limit unnecessary grouping, this segmented group was split into two categories. The first category was for participants under the age of 40, and the second referred to participants aged 40 years or older. Next, the participants were separated according to their stated driving habits, where the first grouping of participants declared that they used their private vehicles either four days or less per week, and the second group stated that they used their vehicles five or more days per average week. The final two segregations of participants had to do with whether the individuals indicated that they were regular carpoolers or if they regularly dropped other individuals off at other locations during their daily commute.

In addition to highlighting the various segregations of participants by rows, columns were used to assist in understanding the classification of question they responded to. Columns A to D, highlighted in blue, describe general estimates pertaining to the travel behaviour of the participants. The questions asked in this section were along the lines of how many kilometres the participants believed they drove per week, and how much they believed this cost them per average week.

Columns E to G, highlighted in orange, reveal the stated amount of disutility that the participants experienced from private vehicle transportation. These disutility factors were broken down into monetary, travel time, and other aspects. The scale used for the indication of disutility experienced ranged from 1 to 10 (1 being almost no disutility experienced, and 10 illustrating extreme disutility experienced by the participants).

Columns H to Q, highlighted in green and purple, illustrate the various perceptions or attitudes that the participants had towards certain aspects regarding private vehicle usage. The responses for these columns were scaled on a range of 1 to 5 (1 being strongly disagree and 5 being strongly agree). The scale of 1-5 was utilised in the hopes of comparing responses to the Mobility Study (see Chapter 4). Unfortunately, due to the relatively low number of participants who took part in this study, this was not possible as statistically relevant findings were not achievable.

Columns H to M, highlighted in green, assist in indicating why participants chose to use their private vehicles instead of other modes of transport. The responses in this section pertain to the participants feeling that private vehicles are essential to perform their job, the safety aspect of private vehicles being higher than that of other modes, the indication that alternatives may not be available to the

participant, the perceived convenience of private transport compared to other modes, the perceived quickness of private vehicle travel compared to other modes, and the perceived cheapness of private vehicle usage compared to other transport modes.

Columns N to Q, highlighted in purple, indicate which potential aspects would entice participants to reduce their private vehicle usage. The aspects tested here included reducing carbon emissions, an increased number of viable alternatives, the reduction of overall congestion experienced, and a reduction in total cost associated with transportation.

5.2.1 Analysis of responses regarding gender

Table 5.1 indicates that men estimated that they drove more kilometres during the week than compared to women. Men also estimated the cost associated with driving their private vehicles to be 85 cents per kilometre more than women. Interestingly, both men and women gave the same level of disutility regarding monetary value; a value of 6. Men valued the disutilities of both time and other aspects to be less impactful than their female counterparts.

When investigating the difference between men and women regarding the green aspects, only one was found to deviate significantly between the two genders. The identified category was the lack of alternatives available for transportation, where men on average rated this aspect 4.17 out of 5 and women on average rated this aspect 3.18 out of 5. This means that women felt that there were more alternatives available to them than men, and therefore men potentially felt "trapped" to using private vehicles even though they estimated that they were spending significantly more money to use their vehicles than their female counterparts.

5.2.2 Analysis of responses regarding age

When investigating how various age groups responded to the first questionnaire, in order to keep sample size number distribution fairly even, the participants were segregated into two age groups: under 40 years of age and 40 years or older.

Overall, it was found that participants aged 40 years or older estimated that they drove farther during an average week, as well as estimated that their private vehicles cost them more per kilometre. Interestingly, even though the older participants estimated higher costs, their perceived impact regarding the monetary disutility associated with their private vehicles was on average noticeably less than their younger counterparts (5.50 vs 6.78). In contrast to this, the older individuals felt that time was a greater disutility than the younger grouping (5.93 vs 4.22). A potential reason for this could be that the older individuals are higher earners due to having greater experience and seniority within

their professions. This higher income leads to a lower monetary disutility even if the estimated costs are higher than for their younger counterparts. This same reasoning could explain the difference in time disutility; due to the older participants being higher earners, their value of time is expected to be greater, and therefore the associated disutility would increase accordingly.

Regarding the aspects indicating why participants chose to utilise their private vehicles instead of an alternative mode (green columns), it can be seen that the younger individuals more strongly agreed with each respective aspect than the older participants, except for Column M. Column M showed that the older participants felt private vehicles were cheaper to use than alternative modes. This again could be explained by assuming that the older individuals receive higher incomes and therefore do not experience the perceived monetary disutility as greatly as the younger individuals.

When investigating what motives could reduce private vehicle usage (purple columns), the younger participants, assuming that they were lower-income earners, indicated that they would be most willing to reduce their vehicle usage if it would translate into reduced total transportation costs, whereas the older individuals indicated that they were most likely to reduce private vehicle usage if more viable alternatives were available to them.

5.2.3 Analysis of responses regarding travel frequency

Moving on from age categories, an investigation was made into understanding whether the regularity of private vehicle usage influenced the participants' perceptions. The participants were requested to indicate how many days per week on average they utilised their private vehicles.

To limit the number of groupings with a limited number of responses, the participants were divided into two categories: one for individuals who utilised their vehicles four days or less per week, and a second for individuals who utilised their vehicles five days or more per average week.

Overall, seven participants indicated that they used their vehicles four days or less a week, and the remaining 16 indicated that they used their vehicles five or more days a week. Both groups estimated that they drove a similar number of kilometres per week (301 km vs 311 km); however, those who utilised their vehicles less frequently perceived the costs of private vehicle transport to be on average R1 more expensive per kilometre (R2.61 vs R1.61). This increased perception of costs per kilometre could potentially be the reason why certain individuals chose to utilise their vehicles less often than others. However, this hypothesis is not supported when investigating the monetary disutility associated with private vehicle usage as the individuals who drove less often and perceived higher costs also assigned a lower level of disutility regarding monetary aspects than those who drove more often and perceived the costs to be lower per kilometre (monetary disutility of 5.43 vs 6.25).

In addition, individuals who drove four days or less per week perceived the time disutility to be the greatest factor when utilising private transport.

When investigating why these participants chose to use their private vehicles instead of alternative transport modes, it was found that convenience and speed regarding private transport were the two aspects that both groups indicated as their main reason.

Interestingly, the lack of alternatives for those who used their vehicles less frequently was also a contributing factor to why they used their private vehicles. This perception filtered through to potential motivators for reducing private vehicle usage, where these same individuals (those who utilise their vehicles four days or less) indicated that they were most likely to reduce private vehicle usage if more suitable alternatives became available. Participants who utilised their vehicles five days or more per week indicated that they were most likely to reduce private vehicle usage if they could reduce their overall transportation costs, which was unsurprising as these individuals felt that the monetary aspect was the greatest disutility with regard to private vehicle usage.

5.2.4 Analysis of responses regarding individuals who carpooled

The final two categories of segmentation investigated whether commuting behaviour with respect to either carpooling to work or potentially dropping other individuals off while on the way to work had an impact on their overall perceptions. In the questionnaire it was found that six individuals carpooled to work. Individuals who carpooled estimated the cost per kilometre to be cheaper on average than those who did not carpool (R1.62/km vs R2.01/km). The only real discrepancy between those who carpooled and those who did not with regard to the disutilities relating to transport was found within the other aspects' disutility, where individuals who carpooled indicated that they perceived a smaller impact regarding this disutility when compared to those who did not carpool (4.17 out of 10 vs 5.24 out of 10). Individuals who carpooled felt that private vehicles were more essential to their daily commute and safer to travel in than other modes with respect to individuals who did not carpool. Additionally, individuals who carpooled felt that there were more alternatives available to private vehicles when compared to those who did not carpool. Following this, the only real difference between the two groups regarding finding a motivation that could reduce private vehicle utilisation is found within alternative transport modes, where more non-carpooling individuals indicated that an increase in alternative modes would entice them to reduce their vehicle usage than those who carpooled (4.35 vs 2.83).

5.2.5 Analysis of responses regarding individuals who dropped off others

The final segmentation is for individuals who drop someone off while on their commute to work. Of these individuals, the ones who dropped others off perceived the cost per kilometre to be more than those who did not (R2.11 vs R1.86). Individuals who did not drop others off on their way to work felt that all three disutilities – monetary, time, and other aspects – were greater sacrifices than those experienced by participants who dropped others off. Individuals who dropped others off felt that private vehicles were less essential than those who did not. At first this seems unintuitive; however, this could potentially be explained by these individuals participating in a "lift club" and therefore, if they were not able to use their own vehicle, they would feel confident in having the ability to arrange a friend/colleague to assist them in reaching their destination.

"Drop off" individuals also perceived a greater lack of alternatives to private transport than those who did not drop others off. With regard to enticing individuals to reduce the usage of their private vehicles, a difference was found within the increased availability of alternatives, where individuals who did not drop others off indicated that they would be more willing to reduce usage if more alternatives were available to them than compared to their counterparts. The other discrepancy is that these individuals indicated that they would be willing to reduce their private vehicle usage if they could experience a reduction in overall congestion. The other variables remain rather similar throughout the dataset.

5.3 FIRST QUESTIONNAIRE VS SECOND QUESTIONNAIRE RESPONSES

This section investigates whether a change occurred regarding either cost per kilometre estimates or the disutilities associated with private vehicle transportation when comparing perceptions before the research exercise to the perceptions of the participants after the research exercise. It should be noted that not all 23 individuals who completed the first questionnaire, along with the tracking exercise, completed the second follow-up questionnaire. Four of the 23 participants who were requested to complete the second survey failed to do so. As such, the comparison sample size consists of the 19 participants who completed both questionnaires. Table 5.2 shows the results of these findings, which will be discussed further. The values illustrated are equivalent to the responses from the second questionnaire minus the responses from the first questionnaire. Values highlighted in green indicate an increase in perceived value in the second questionnaire and red cells indicate a reduction in perceived value.

Table 5.2: Comparison of responses between Questionnaires 1 and 2

ALL PARTICIPANTS	Number	Est. cost/km	Monetary	Time	Other
Overall	19	R 0.52	0.37	0.79	0.26
GENDER	Number	Est. cost/km	Monetary	Time	Other
Man	11	R 0.12	-0.09	0.36	-0.18
Woman	8	R 1.07	1.00	1.38	0.88
AGE	Number	Est. cost/km	Monetary	Time	Other
Under 40	8	R 0.74	-0.25	1.25	0.00
40 or older	11	R 0.36	0.82	0.45	0.45
DRIVE OFTEN	Number	Est. cost/km	Monetary	Time	Other
Four days or less	7	R 0.73	0.43	-0.43	0.00
Five days or more	12	R 0.40	0.33	1.50	0.42
CARPOOL	Number	Est. cost/km	Monetary	Time	Other
Yes	6	R 0.07	1.00	2.00	1.17
No	13	R 0.73	0.08	0.23	-0.15
DROP OFF	Number	Est. cost/km	Monetary	Time	Other
Yes	4	R 0.51	0.25	2.50	1.00
No	15	R 0.52	0.40	0.33	0.07

From Table 5.2 it can be observed that the 19 participants who completed the first and second questionnaire had a shift in overall perception and estimation. The average participant estimated the cost of utilising a private vehicle to be 52 cents more expensive per kilometre after the research exercise had been completed. Similarly, all three disutilities associated with transportation appeared to have a higher perceived impact on the participants' lives. This can be deduced due to the average increase in the disutility values, where monetary sacrifice increased by an average of 0.37, time sacrifice increase by an average of 0.79, and other sacrifices increased by an average of 0.26. This could possibly lead to an indication that the information-sharing exercise in this study holds potential for shifting the perceptions of individuals.

5.3.1 Comparison of responses with regard to gender

When investigating how genders' perceptions were influenced after the research exercise, it was found that both men and women estimated their cost per kilometre to be higher after the exercise; however, the women's estimates were now substantially higher than those of the men (R1.07 per km vs R0.12 per km). The perceptions of disutility impact also adjusted after the exercise. Men perceived the monetary and other aspects to be slightly less impactful, and time sacrifice to have a greater perceived impact after the research exercise; however, these numbers are reasonably similar to those before the research exercise. Women, on the other hand, experienced a greater shift in perception; they valued the impact of monetary, time, and other sacrifices much greater than before the study, with an increase in values of 1, 1.38, and 0.88 respectively.

5.3.2 Comparison of responses with regard to age

The different age groups experienced varying changes in perception regarding the sacrifices associated with transportation; however, when investigating the estimated cost per kilometre, both groups estimated private vehicles to be more expensive after the research exercise, with increased estimations ranging from 74 cents per kilometre for individuals under 40, to 36 cents per kilometre for individuals aged 40 or above. As mentioned, there were various changes in perception when investigating the perceptions of disutility. The majority of shifts in perception were found regarding perceived monetary disutility, where younger individuals had a reduction in perceived monetary disutility (-0.25) regarding private vehicle usage, and older participants experienced an increase in perceived monetary disutility (+0.82). The perception of time disutility increased for both age groups, but increased by a greater amount for younger participants, and the perceived impact of other aspects had not changed at all for the younger participants but increased by 0.45 for those aged 40 years and older.

5.3.3 Comparison of responses with regard to vehicle usage frequency

It appears that the number of times per week participants utilised their vehicle did not greatly impact the post-research exercise estimations of cost, as both groups estimated their cost per kilometre to be higher during the second questionnaire, with the increases ranging from 40 to 73 cents per kilometre. Participants who travelled four days a week or less perceived their monetary sacrifice to increase by a similar amount compared to those who drove five days a week or more (+0.43 and +0.33 respectively). One major difference when comparing the values of pre- versus post-research perception between these two groups is the change in perceived impact of time disutility. Participants who used their vehicles four days or less per week experienced a decrease in perceived time disutility (-0.43), while those who used their vehicles more frequently experienced an increase in disutility (+1.50). This could potentially be explained by participants previously not truly understanding how much time they spent using their private vehicles and the information provided during the research exercise assisting in informing them of the actual time spent driving.

5.3.4 Comparison of responses with regard to individuals who carpooled

When investigating the alterations of estimations and perceptions of individuals who carpooled compared to those who do not, it can be seen that both sets of participants estimated their private vehicle costs to be more after the research exercise had been completed. However, it should be taken into consideration that individuals who carpooled only marginally increased their estimated costs when compared to those who did not carpool: 7 cents compared to 73 cents per kilometre.

Additionally, there were quite substantial increases in all the values for the three categories, indicating perceived impact of disutility for individuals who carpooled regularly: an increase of 1 in monetary sacrifice, an increase of 2 in time sacrifice, and an increase of 1.17 in other aspects sacrifice. Individuals who did not carpool experienced a much less significant increase in monetary sacrifice and travel time associated with transportation and actually perceived the impact of other aspects associated with transport to be marginally less than previously indicated.

5.3.5 Comparison of responses with regard to individuals who dropped off others

The final results acquired from the investigation between differences in the first and second questionnaire identify shifts in estimations and perceptions among participants who dropped off other individuals while commuting to work and those who did not. Both sets of individuals were found to very similarly increase their estimates of cost per kilometre regarding their private vehicles: a 51 cents increase for participants who dropped others off, and a 52 cents increase for those who did not. For those who did not drop off others, there were also minor increases in perceived sacrifice impact for monetary cost, travel time, and other aspects, where each of these values increased by 0.4, 0.33, and 0.07 respectively. In contrast, participants who dropped off others were found to perceive the impacts of these sacrifices as much more significant. For those who dropped off others, it was found that their average monetary sacrifice increased by a value of 0.25, average travel time sacrifice increased by 2.5, and other aspects increased on average by 1. This significant increase in time disutility experienced by participants who dropped others off during their commute may be due to a better understanding of how much time they spent driving, as informed by the informational invoices.

5.4 INVESTIGATING ACTUAL TRAVEL PATTERNS SEGREGATED BY DEMOGRAPHICS

Following the investigation into the participant responses to various questionnaires, an investigation into how the individuals actually drove throughout the study regarding their various segmented groupings is now made. This information can be found in Table 5.3; the participant segregation was kept the same as in Table 5.1 and Table 5.2.

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Table 5.3: Average daily driving patterns per segmented group

ALL PARTICIPANTS	Number	Avg. dist. km	Avg. dur.	Avg. trips
Overall	23	46.86	01:06:40	3.97
GENDER	Number	Avg. dist. km	Avg. dur.	Avg. trips
Man	12	44.96	01:05:32	4.24
Woman	11	48.95	01:07:55	3.67
AGE	Number	Avg. dist. km	Avg. dur.	Avg. trips
Under 40	9	44.50	01:03:27	3.79
40 or older	14	48.38	01:08:44	4.08
DRIVE OFTEN	Number	Avg. dist. km	Avg. dur.	Avg. trips
Four days or less	7	43.01	00:57:32	3.60
Five days or more	16	48.55	01:10:40	4.13
CARPOOL	Number	Avg. dist. km	Avg. dur.	Avg. trips
Yes	6	38.33	01:05:41	4.50
No	17	49.88	01:07:01	3.78
DROP OFF	Number	Avg. dist. km	Avg. dur.	Avg. trips
Yes	6	31.55	00:55:22	3.77
No	17	52.27	01:10:39	4.03

Table 5.3 can be used to determine the average number of kilometres driven, the average amount of time spent in vehicles, and the average number of trips taken per day for the various categories over the four-week tracking period. Averages for the whole group illustrate that the 23 participants took nearly four trips per day (3.97 trips), drove 46.86 km on an average day, and spent an average of 1 hour 6 minutes and 40 seconds to take these trips.

All segmented groups are discussed with particular emphasis on the categories that deviate by more than a 10% margin when compared to the average values for the group (all 23 participants) as a whole. This translates to a margin of approximately 4.7 km per average day in distance travelled, approximately six minutes for average duration spent travelling per day, and approximately 0.4 trips taken per average day.

5.4.1 Actual travel pattern differences regarding gender

It was found that, on average, men drove fewer kilometres and spent less time in their vehicles per day; however, they took a higher number of trips on average than women. When looking at the average time spent in a vehicle per kilometre driven, men were found to take longer than women (1h05m/44.95 km = 1.46 min. per km vs 1h07m/48.95 km = 1.39 min. per km). This, coupled with the fact that men take a higher number of trips than women on average, could be an indication that men are less inclined to plan their trips, which leads to taking less efficient routes, and, due to the lack of planning, taking more frequent trips.

5.4.2 Actual travel pattern differences regarding age

Within the two age groups, it was found that individuals under the age of 40 were less inclined to travel longer distances compared to the older age grouping. Younger participants were also found to spend less time in their vehicles and took fewer trips on average per day compared to participants aged 40 or above.

5.4.3 Actual travel pattern differences regarding travel frequency

When investigating travel frequency (how often people travelled), it was found that individuals who indicated that they used their vehicle four days a week or less drove fewer kilometres per average day; they also spent significantly less time in their vehicles and took fewer trips. Interestingly, the individuals who drove fewer days per week also had a higher average speed while driving (44.8 km/h vs 41.3 km/h). This could potentially be explained by assuming that these individuals have greater flexibility regarding their working conditions (i.e. the times they are expected to arrive at work). Due to this greater flexibility, these individuals have the ability to adjust their travel periods in such a way as to avoid congestion, which would therefore allow them to travel at a higher average speed compared to those who are less flexible regarding their travel times and are assumed to be individuals who use their private vehicles five times or more per week.

5.4.4 Actual travel pattern differences regarding individuals who carpooled

It was established that individuals who regularly carpooled drove approximately 10 km less per average day than those who did not carpool (38.3 km vs 49.9 km). Understandably, the carpooling participants also spent less time in their private vehicles. However, they only spent about two minutes a day less traveling by private vehicle, even though they travelled about 10 km less. This could potentially be explained by the fact that carpoolers are dependent on the other individuals in the vehicle, and, as such, trip routes selected may be less than optimal, which would increase the relative amount of time spent in the private vehicle. The carpooling individuals were also found to take on average almost one more trip per day compared to those who did not carpool regularly. This again could be explained by the nature of carpooling, seeing as one normally carpools on a regular trip pattern, such as a commute to work. If any additional trips were needed (such as a trip to the grocery store), these would require the individual to first stop at home before commencing their next trip.

5.4.5 Actual travel pattern differences regarding individuals who dropped off others

It was also found that participants who regularly dropped off other individuals on their commute to work drove fewer kilometres than individuals who did not drop off others on their commute to work: 31.55 km compared to 52.27 km on average per day. This could potentially be explained by assuming that individuals who dropped off others would only be willing to do so if the drop-off and collection points were on their route to work. Unsurprisingly, the participants who dropped off others, and drove fewer kilometres, also spent less time in their vehicles on average. However, when investigating average travel speed, it was found that the participants who dropped off others travelled slower than those who did not (34.1 km/h vs 44.5 km/h). This could be explained by the nature of dropping off other individuals, as the decrease in average speed could be attributed to the time spent waiting for these individuals at collection and drop-off locations. On a final note, the number of trips undertaken between both subsets of participants was not vastly different (3.77 vs 4.03).

5.5 DRIVING PATTERNS SEGREGATED BY VEHICLE CHARACTERISTICS

In this section, instead of grouping the individuals by demographic and travel characteristics in an attempt to discern any notable difference in travel behaviour, the participants were grouped according to their private vehicles' characteristics. This was done in hopes of determining whether a particular vehicle characteristic encouraged or potentially discouraged the utilisation of the particular private vehicle. These groupings were divided by vehicle type, engine size, the type of fuel that the vehicle used, whether the participant was also the registered owner of the vehicle or not, the monetary value of the vehicle, and the age of the vehicle.

The values investigated pertaining to these various grouping are once again the average number of kilometres travelled per day, the average amount of time spent in the vehicle per day, and the average number of trips taken per day. These values and the various grouping segregations can be seen in Table 5.4.

Table 5.4: Average daily driving patterns segregated by vehicle characteristics

ALL PARTICIPANTS	Number	Avg. dist. km	Avg. dur.	Avg. trips
Overall	23	46.86	01:06:40	3.97
VEHICLE TYPE	Number	Avg. dist. km	Avg. dur.	Avg. trips
Bakkie	1	32.99	00:50:25	2.82
Hatchback	4	56.46	01:07:17	3.01
Sedan	11	50.91	01:10:14	4.14
SUV	7	37.00	01:03:02	4.41
ENGINE SIZE	Number	Avg. dist. km	Avg. dur.	Avg. trips
1800 cc or less	8	42.13	01:04:04	3.49
1801 cc - 2500 cc	8	65.69	01:21:22	4.56
2501 cc or more	7	30.76	00:52:51	3.83
FUEL TYPE	Number of	Avg. dist. km	Avg. dur.	Avg. trips
Petrol	16	54.19	01:11:08	3.82
Diesel	7	30.11	00:56:28	4.30
REGISTERED OWNER	Number of	Avg. dist. km	Avg. dur.	Avg. trips
Yes	21	47.16	01:07:28	3.89
No	2	43.76	00:58:17	4.75
VEHICLE VALUE	Number of	Avg. dist. km	Avg. dur.	Avg. trips
R100 000 or less	7	54.90	01:13:43	3.87
R100 001 - R199 999	10	36.40	00:58:36	4.24
R200 000 or more	6	67.17	01:24:47	3.87
VEHICLE AGE	Number of	Avg. dist. km	Avg. dur.	Avg. trips
Less than 5 years	8	47.58	01:04:39	3.27
5-10 years	9	42.28	01:06:33	4.62
More than 10 years	6	52.78	01:09:33	3.90

The first category of discussion is the values relating to the average distance travelled per day, the average amount of time spent in vehicle per day, and the average number of trips taken per day for the group of participants as a collective. The averages for the overall group remains the same in Table 5.4 as in Table 5.3.

5.5.1 Discussion of travel patterns segregated by vehicle type

Of the vehicle types used by the research participants, sedans were the most popular with a count of 11, followed by seven sport utility vehicles (SUVs), four hatchbacks, and one *bakkie* (utility vehicle).

Investigating the usage statistics of these various vehicles types (excluding *bakkies*) revealed that the vehicles that drove the fewest kilometres per day on average were *bakkies* at 32.99 km per average day, SUVs drove on average 37 km per average day, whereas the distance driven by hatchbacks and sedans remained reasonably similar (56.5 km and 50.9 km per day respectively). Individuals across three vehicle types (hatchback, sedan, and SUV) were found to spend similar amounts of time in their vehicles, ranging from 1 hour and 3 minutes to 1 hour and 10 minutes per average day, the exception being *bakkies* where the participant spent less than an hour per day using their vehicle at 50 minutes and 25 seconds on average. When investigating average vehicle speed, it was found that bakkies were generally driven at significantly slower speeds on average at 27.5km/h. SUVs were driven faster than *bakkies* but still slower on average (around 35 km/h) than the two other vehicle types (43.6 km/h for

sedans and 50.6 km/h for hatchbacks). A potential reason why *bakkies* and SUVs are driven shorter distances at slower speeds could be due to their physical size and general nature in which participants would use these vehicles (seeing as they are both classed as utility vehilces). Additionally, SUVs tend to also be larger-than-average vehicles and thus require their drivers to be more cautious when manoeuvring them within an urban area. *Bakkies* on the other hand are often purchased with the intent to transport larger objects or goods which can also require more cautious driving techniques. These factors could contribute to the values found in Table 5.4.

5.5.2 Discussion of travel patterns segregated by vehicle engine size

When investigating the various travel behaviour statistics with regard to vehicle engine sizes, the participants' vehicles were segmented into three separate groups: those with engine sizes of 1 800 cubic centimetres (cc) or less, those with engine sizes of 1 801 cc to 2 500 cc, and those with engine sizes greater than 2 500 cc. The grouping of vehicles with engine sizes ranging between 1 801 cc and 2 500 cc can in particular be highlighted. Participants with vehicles that were characterised as having an engine size that fell into this grouping were found to drive significantly longer distances, spent more time in their vehicles, and took more trips on an average day than those in the other two groupings. When investigating average speeds, it was found that participants with vehicle engine sizes ranging between 1 800 cc and 2 500 cc travelled at a higher average speed (48.7 km/h vs 39.5 km/h for less than 1 800 cc and 34.8 km/h for more than 2 500 cc). The indicators of increased travel distance, coupled with higher average travelling speeds, could potentially indicate that individuals who owned a vehicle with an engine size between 1 800 cc and 2 500 cc were more likely to travel on national highways than urban/rural roads when commuting to work. This would make logical sense as vehicles within this range tend to be more comfortable to drive long distances with than vehicles with smaller engines while maintaining better fuel economy than vehicles with larger engines, thus striking a good balance between comfort and performance.

5.5.3 Discussion of travel patterns segregated by vehicle fuel type

The majority of the participants within this research exercise were in possession of vehicles with petrol engines instead of diesel engines. Sixteen of the 23 participants utilised petrol vehicles. When comparing these two segments of the sample population, on average participants with petrol vehicles drove approximately 14 km farther and spent nearly 15 minutes more time in their vehicles per day. An investigation into average vehicle speeds indicated that the petrol vehicles travelled on average 45.8 km/h, while the diesel vehicles travelled at 31.9 km/h on average. This could potentially once

again be attributed to assuming that petrol vehicles were more likely to drive on national highways, whereas their diesel counterparts were used primarily on rural and urban roads.

5.5.4 Discussion of travel patterns segregated by vehicle value

To investigate the relationship between vehicle value (in rands) and average distance travelled, time spent in vehicle, and the number of trips per day for each segment of the sample size, participants' vehicles were segregated into 3 categories. Vehicles valued as less than R100 000, between R100 001 and R200 000, or more than R200 000. Vehicles worth more than R200 000 were found to drive farther distances per average day than the other two categories. They were also found to drive faster average speeds (47.7 km/h) than vehicles valued between R100 000 – R200 000 (37.3 km/h) and vehicles valued as less than R100 000 (44.8 km/h). This could potentially indicate that individuals who own more expensive vehicles are more likely to require to drive farther distances due to their circumstances, or alternatively, they chose to drive farther because they are less price sensitive.

5.5.5 Discussion of travel patterns segregated by vehicle age

In the final category, an investigation into the travel behaviour variables was made in an attempt to determine whether travel behaviour has any relationship with the age of the vehicle utilised by the participants. The vehicle age groupings for this category were in increments of five years, with the first grouping being for newer vehicles that were identified as less than five years old, the second grouping ranged for vehicles five to ten years old, and the final grouping for vehicles older than ten years. Overall, it was found that the older vehicles (more than ten years old) were most likely to drive farther distances on an average day, and that medium-aged vehicles (five to ten years old) on average took a greater number of trips. The newest vehicles (under five years old) on average took the lowest number of trips per day. This could potentially be explained by the relative caution that participants felt toward utilising new vehicles, and would therefore refrain from using them for unnecessary trips.

5.6 GLOBAL POSITIONING SYSTEM (GPS) DATA INVESTIGATION

The focus of this section is to investigate the travel behaviour patterns of participants over the entire four-week study period in order to analyse and better understand any changes in behaviour that may have occurred during the research period. The data relating to kilometres driven, time spent in vehicle, and the number of trips undertaken by the participants are segmented into daily, weekly, and four-weekly datasets to assist with analysis. These values will later be translated into monetary values and carbon emissions to further the discussion and better understand the potential impacts that a reduction in private vehicle utilisation can have.

Table 5.5: Summary data of total distance, total time, and total trips during the four-week period

Device	Monthly totals		
	Kilometres	Time	Trips
TBI 1	1006.4	35:10:00	159
TBI 2	1174.5	33:11:00	133
TBI 3	1113.9	26:19:00	88
TBI 4	1156.9	37:16:00	89
TBI 5			
TBI 6	2854.9	43:57:00	133
TBI 7	1016.8	31:34:00	158
TBI 8	636.9	21:00:00	141
TBI 9	381	10:45:00	89
TBI 10	985.7	21:04:00	67
TBI 11	751.4	29:43:00	165
TBI 12	2455.8	52:07:00	189
TBI 13	376.5	17:30:00	75
TBI 14	2321.4	48:18:00	124
TBI 15	782.8	19:29:00	96
TBI 16	1171.9	32:49:00	43
TBI 17	818.5	32:59:00	102
TBI 18	2103	47:08:00	160
TBI 19			
TBI 20	1514.3	29:21:00	65
TBI 21	1813.6	33:24:00	125
GPS 1	970.85	26:49:40	102
GPS 2	2783.78	36:53:40	92
GPS 3	923.73	23:31:32	79
GPS 4	1066.16	25:16:11	80
GPS 5			
Average	**1312.2**	**31:06:44**	**111.04**
Median	**1066.2**	**31:34:00**	**102**

Table 5.5 reveals the total distance, time, and number of trips undertaken by each participant over the four-week study period. Table 5.5 shows that three participants did not complete the research exercise, as previously mentioned, and as such the data relating to their devices (TBI 5, TBI 19, and GPS 5) were omitted in order to ensure that only complete datasets were analysed. In order to avoid confusion, all subsequent tables revealing data with reference to particular device names will contain TBI 5, TBI 19, and GPS 5 data and other rows were thus removed from the dataset entirely.

In the final two rows of Table 5.5, the average and median values for the research period are recorded in terms of distance travelled, time spent in vehicle, and total number of trips across the four-week period. Table 5.6 investigates the descriptive statistics in greater detail.

Overall, Table 5.6 shows that from the 23 individuals who participated in the research exercise, there was a rather uneven distribution as illustrated by the range. Investigating the range does not alone determine that there is uneven distribution among the dataset but it does assist in identifying that outliers may be present within the sample group. The values that assist in illustrating that uneven distribution was present are the mean and standard deviation values for kilometres, time, and trips. In

all three cases, when comparing the standard deviation to the mean, it is discovered that standard deviation, which illustrates the dispersion of average data from its mean, is relatively high in contrast to the mean value.

Table 5.6: Summary statistics for total kilometres driven, time spent in vehicle, and number of trips

Kilometres		Time		Trips	
Mean	1312.21	Mean	31:06:44	Mean	111.04
Standard Error	151.04	Standard Error	2:08:59	Standard Error	8.00
Median	1066.16	Median	31:34:00	Median	102.00
Standard Deviation	724.38	Standard Deviation	10:18:35	Standard Deviation	38.35
Sample Variance	524727.92	Sample Variance	4:25:44	Sample Variance	1470.41
Skewness	0.97	Skewness	6:11:30	Skewness	0.32
Range	2478.40	Range	41:22:00	Range	146
Minimum	376.50	Minimum	10:45:00	Minimum	43
Maximum	2854.90	Maximum	52:07:00	Maximum	189
Sum	30180.72	Sum	715:35:03	Sum	2554
Count	23	Count	23	Count	23

In order to ascertain whether any relationship exists between the three variables seen above in reference to kilometres driven, time, and number of trips, a correlation table was developed (see Table 5.7).

Table 5.7: Investigation into correlation between kilometres driven, time spent, and number of trips

KM	*TIME*	*TRIP*
1		
0.82110238	1	
0.30144	0.53744296	1

Given that all three variables in Table 5.7 are related to travel behaviour, the variables are therefore undoubtedly interlinked and influence one another. As an example, a farther distance travelled usually translated into a longer time period needed to cover the additional distance.

Table 5.7 aims to demonstrate how strongly correlated the relationships between distance driven, time spent in vehicle, and number of trips may be. Generally speaking, when investigating correlation, as the values are approach 1 or -1, the linear relationships between the variables are viewed as stronger. Negative values represent a negative linear relationship, whereas positive values represent a positive linear relationship. Table 5.7 shows that there is a reasonably strong positive linear relationship between kilometres driven and the amount of time spent in vehicles. This is easily explained, as mentioned in the example found in the previous paragraph. However, when referring to the relationship between distance driven and time spent in vehicle, there are many other variables that also influence the correlation; these include, but are not limited to, the time of day that the journey is undertaken and the type of road used for the journey.

One interesting note is that the number of trips taken appeared to be less correlated to the time spent in vehicles and in particular to distance travelled. This may imply that distance driven is not particularly correlated to the number of trips taken as certain participants may have been more likely to take multiple short trips during the study period than others.

5.6.1 Investigation of distance driven

In order to more thoroughly investigate the number of kilometres driven by participants, a breakdown of the distance travel patterns recorded during the study period for each participant was made. Table 5.8 shows the data relating to each participant's distance travelled in kilometres, as segregated into weekly intervals. The right column illustrates the total distance travelled over the four-week period. The bottom two rows display the average and median values per respective week and the total for the group as a whole.

Table 5.8: Distances driven by participants per week in kilometres

Device	Week 1	Week 2	Week 3	Week 4	Month total
TBI 1	126.4	380.4	188	311.6	1006.4
TBI 2	391.4	295.2	205.3	282.6	1174.5
TBI 3	264	283	282.7	284.2	1113.9
TBI 4	260.9	289.5	336.1	270.4	1156.9
TBI 6	467.8	370.9	1417.8	598.4	2854.9
TBI 7	246.4	305.6	236.1	228.7	1016.8
TBI 8	349.6	118.3	82.8	86.2	636.9
TBI 9	113	32	89	147	381
TBI 10	296	107.6	331.7	250.4	985.7
TBI 11	94.9	224.3	241.4	190.8	751.4
TBI 12	551.1	514	648.6	742.1	2455.8
TBI 13	274.9	61.8	26.2	13.6	376.5
TBI 14	62.1	489.1	1047.4	722.8	2321.4
TBI 15	365.8	205.2	56.8	155	782.8
TBI 16	394.8	406.3	348.8	22	1171.9
TBI 17	236.2	210.9	182.3	189.1	818.5
TBI 18	571	504	499.1	528.9	2103
TBI 20	530.7	399.5	214.7	369.4	1514.3
TBI 21	163.6	499.2	553.2	597.6	1813.6
GPS 1	542.49	129.91	144.21	154.24	970.85
GPS 2	566.48	677.85	714.98	824.47	2783.78
GPS 3	139.6	117.45	411.31	255.37	923.73
GPS 4	244.67	248.45	271.21	301.83	1066.16
Average	**315.4 km**	**298.7 km**	**370.9 km**	**327.2 km**	**1312.2 km**
Median	**274.9 km**	**289.5 km**	**271.2 km**	**270.4 km**	**1066.2 km**

Table 5.8 shows that the values between the participants once again have a wide distribution. By examining the average and median values per week, it can be observed that there are differences with regard to the number of kilometres driven on a weekly basis, with no obvious trend being formed. It must be noted that, similar to Table 5.5, these differences between average and median values in

Table 5.8 could potentially be due to a few extreme cases where participants drove excessively more or less than the average participant would; thus influencing the average values.

Given that the total number of kilometres driven per week were recorded in Table 5.8, and that the first questionnaire captured data relating to various vehicle characteristics, it is possible to utilise Equation 3.1 to calculate the monetary expense that the participants incurred on their private transport during the period.

Table 5.9 reveals the calculated monetary expenditure incurred by each participant due to using their private vehicle during the four-week tracking period.

Table 5.9: Monetary expenditure of participants during research exercise period

Device	Week 1	Week 2	Week 3	Week 4	28-Day cost	Est. cost p.a.
TBI 1	R527.85	R1 588.55	R785.09	R1 301.24	R4 202.73	R54 785.54
TBI 2	R1 793.20	R1 352.46	R940.58	R1 294.73	R5 380.97	R70 144.81
TBI 3	R639.59	R685.62	R684.90	R688.53	R2 698.65	R35 178.77
TBI 4	R874.72	R970.61	R1 126.84	R906.57	R3 878.74	R50 562.13
TBI 6	R2 396.91	R1 900.42	R7 264.52	R3 066.08	R14 627.94	R190 685.60
TBI 7	R902.76	R1 119.66	R865.02	R837.91	R3 725.35	R48 562.62
TBI 8	R1 931.89	R653.73	R457.55	R476.34	R3 519.51	R45 879.32
TBI 9	R526.89	R149.21	R414.98	R685.42	R1 776.49	R23 157.80
TBI 10	R1 785.32	R648.99	R2 000.65	R1 510.29	R5 945.25	R77 500.57
TBI 11	R618.02	R1 460.71	R1 572.07	R1 242.55	R4 893.34	R63 788.21
TBI 12	R1 681.32	R1 568.14	R1 978.78	R2 264.04	R7 492.28	R97 667.19
TBI 13	R1 711.53	R384.77	R163.12	R84.67	R2 344.09	R30 556.87
TBI 14	R558.23	R4 396.59	R9 415.24	R6 497.36	R20 867.41	R272 021.63
TBI 15	R2 430.21	R1 363.26	R377.35	R1 029.75	R5 200.57	R67 793.16
TBI 16	R1 746.08	R1 796.94	R1 542.64	R97.30	R5 182.96	R67 563.61
TBI 17	R439.97	R392.84	R339.57	R352.24	R1 524.62	R19 874.51
TBI 18	R1 450.83	R1 280.59	R1 268.14	R1 343.86	R5 343.41	R69 655.13
TBI 20	R1 735.84	R1 306.70	R702.25	R1 208.25	R4 953.05	R64 566.52
TBI 21	R417.32	R1 273.38	R1 411.13	R1 524.39	R4 626.22	R60 306.10
GPS 1	R1 281.04	R306.77	R340.54	R364.22	R2 292.57	R29 885.22
GPS 2	R1 427.93	R1 708.66	R1 802.25	R2 078.24	R7 017.07	R91 472.57
GPS 3	R536.26	R451.17	R1 580.01	R980.98	R3 548.42	R46 256.14
GPS 4	R771.58	R783.50	R855.27	R951.84	R3 362.19	R43 828.53
Average	**R1 225.45**	**R1 197.53**	**R1 647.33**	**R1 338.56**	**R5 408.86**	**R70 508.37**
Median	**R1 281.04**	**R1 273.38**	**R940.58**	**R1 029.75**	**R4 626.22**	**R60 306.10**

The final column in Table 5.9 is an estimate of the total cost per annum that the participants would incur if they were assumed to continue their recorded travel behaviour patterns for the duration of one year. The bottom two rows illustrate the average and median values for the respective columns.

On average, it appears that the participants spent approximately R5 400 over the four-week tracking period. Taking these figures and then utilising the assumption that the participants travelled similarly to the travel behaviour measured during the exercise period allow for the approximation that participants within this research study on average spent about R70 000 per annum, with median spending of about R60 000 per annum. These amounts are quite substantial and imply that, on

average, the participants are effectively being "charged" more than R4.10 per kilometre (R5 408/1 312 km = R4.12 per km), or R4.30 per kilometre in terms of median values (R4 626/1 066 km = R4.34 per km). In order to investigate whether there was a trend present regarding the monetary expenditure during the study period, Figure 5.1 was created.

Figure 5.1: Comparing average and median monetary expenditure of participants during the study period

The graphs in Figure 5.1 illustrate interesting and contradictory findings. The average monetary expenditure per week appears to be on a positive trend, and thus illustrates that the participants were spending more on their private transport as time went on. This is illustrated by the dotted black line in the left graph.

At the same time, median monetary expenditure is shown to be on a negative or decreasing trend, as shown by its trend line. Unfortunately, when performing a regression analysis, it was found that the relationships were not statistically significant, and therefore it should be assumed that monetary expenditure remained fairly constant throughout the study period. The lack of statistical significance could possibly be due to the short time period during which the study was performed in addition to the low number of total participants (23).

Utilising the weekly number of kilometres driven by each participant and the information collected from the first questionnaire, and utilising Equation 3.2, it is possible to calculate the amount of carbon emissions produced by each participant.

Table 5.10 reveals the calculated carbon emissions produced by each individual by using their tracked private vehicle data during the tracking period.

Table 5.10: Carbon emissions of participants during the research exercise period

Device	Week 1	Week 2	Week 3	Week 4	28-Day emissions	Annual emissions
TBI 1	40994.05 g	123371.33 g	60972.16 g	101058.11 g	326395.65 g	4254800.41 g
TBI 2	110625.30 g	83435.33 g	58025.99 g	79874.06 g	331960.68 g	4327344.58 g
TBI 3	44753.28 g	47974.16 g	47923.30 g	48177.58 g	188828.33 g	2461512.13 g
TBI 4	44227.77 g	49076.04 g	56975.67 g	45838.21 g	196117.69 g	2556534.15 g
TBI 6	86309.10 g	68431.05 g	261584.10 g	110404.80 g	526729.05 g	6866289.40 g
TBI 7	45460.80 g	56383.20 g	43560.45 g	42195.15 g	187599.60 g	2445494.79 g
TBI 8	113382.27 g	38367.06 g	26853.70 g	27956.38 g	206559.41 g	2692649.43 g
TBI 9	19155.76 g	5424.64 g	15087.28 g	24919.44 g	64587.12 g	841939.24 g
TBI 10	83661.44 g	30412.06 g	93751.69 g	70773.06 g	278598.25 g	3631727.16 g
TBI 11	23336.86 g	55157.61 g	59362.67 g	46919.63 g	184776.77 g	2408697.23 g
TBI 12	113162.87 g	105544.76 g	133183.52 g	152382.81 g	504273.97 g	6573571.42 g
TBI 13	89155.57 g	20042.98 g	8497.18 g	4410.75 g	122106.48 g	1591745.19 g
TBI 14	16124.89 g	126999.71 g	271967.88 g	187682.25 g	602774.72 g	7857599.08 g
TBI 15	55243.12 g	30989.30 g	8577.94 g	23408.10 g	118218.46 g	1541062.02 g
TBI 16	66926.50 g	68875.98 g	59128.58 g	3729.44 g	198660.49 g	2589681.36 g
TBI 17	40040.62 g	35751.77 g	30903.50 g	32056.23 g	138752.12 g	1808732.99 g
TBI 18	117249.14 g	103491.36 g	102485.19 g	108604.33 g	431830.02 g	5629212.76 g
TBI 20	108973.94 g	82033.33 g	44086.50 g	75852.60 g	310946.36 g	4053407.93 g
TBI 21	33593.62 g	102505.73 g	113594.09 g	122711.18 g	372404.62 g	4854560.28 g
GPS 1	86060.61 g	20608.92 g	22877.47 g	24468.63 g	154015.64 g	2007703.93 g
GPS 2	140062.18 g	167598.41 g	176778.81 g	203850.21 g	688289.61 g	8972346.64 g
GPS 3	32032.62 g	26950.08 g	94379.19 g	58597.20 g	211959.09 g	2763038.08 g
GPS 4	36950.06 g	37520.92 g	40958.13 g	45582.37 g	161011.48 g	2098899.69 g
Avg (grams)	**67281.84 g**	**64649.81 g**	**79631.09 g**	**71367.50 g**	**282930.24 g**	**3688197.82 g**
Avg (kilograms)	**67.28 kg**	**64.65 kg**	**79.63 kg**	**71.37 kg**	**282.93 kg**	**3688.20 kg**
Median (grams)	**55243.12 g**	**55157.61 g**	**58025.99 g**	**48177.58 g**	**206559.41 g**	**2692649.43 g**
Median (kg)	**55.24 kg**	**55.16 kg**	**58.03 kg**	**48.18 kg**	**206.56 kg**	**2692.65 kg**

Table 5.10, illustrating carbon emissions, follows a similar format when directly compared to Table 5.9, which illustrated monetary expenses. The only difference is the bottom four rows, where Table 5.10 contains two additional rows to allow for the conversion of carbon emissions from grams to kilograms.

When investigating the total amount of carbon emissions produced by the participants per annum, it was found that, on average, a participant would produce approximately 3.7 tonnes of CO_2, and the median value reflects approximately 2.7 tonnes of CO_2 per annum. It is possible that in the future, South African car users may be required to contribute around R120 per tonne of CO_2 initially as per (The Carbon Report's Blog, 2016). This means that individuals would potentially need to contribute approximately R444 (3.7 tonnes x R120 per tonne) on average per annum or around R324 (2.7 tonnes x R120 per tonne) on the median value per annum. This would increase monetary expenditure by approximately 0.6% on average (R444 / R70 508 x 100) and approximately 0.5% on the median value (R324 / R60 306 x 100).

These increases in monetary expenditure may seem marginal given that they are minor in comparison to the total annual figures. However, these carbon tax estimates are viewed to be the initial amounts that individuals will be expected to contribute toward their carbon impact and may increase rapidly once implemented. If this carbon tax was increased to R500 per tonne of CO_2, which has not been

ruled out, the average cost incurred would be around R1 850 per annum (which translates to an increase of 2.6% in terms of monetary cost on average). The median increase could be expected to be around R1 350 per annum (which translates to an increase of 2.2%). It is therefore reasonable to assume that these cost measures could begin to influence private vehicle usage once they are introduced.

Unfortunately, when investigating the statistical significance of the relationships regarding carbon emission generation over time in terms of the study period, the relationships were once again found to be statistically insignificant. Figure 5.2, similar to the monetary expenditure section of this chapter, contains graphs that illustrate the average and median values of carbon emissions to indicate any trends that may be present even if not found to be particularly significant. It should be noted that even though both Figure 5.1 and Figure 5.2 utilised the same underlying kilometres travelled, due to the varying vehicle characterises found within this study, the trends illustrated are similar regarding gradient but are not exactly the same.

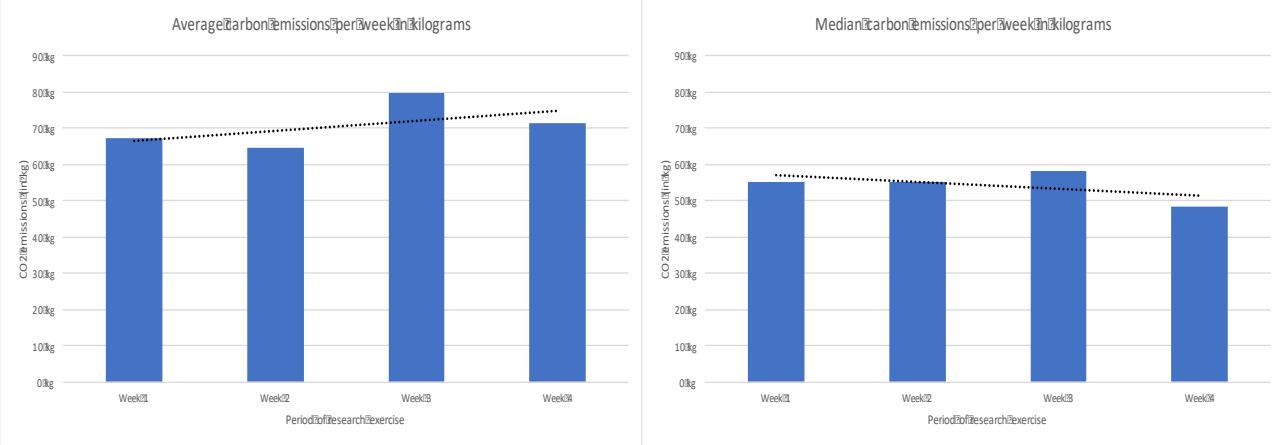

Figure 5.2: Comparing average and median carbon emissions of participants per week during research period

When examining the graphs in Figure 5.2 that compare the average and median values of carbon emissions during the four weeks of the research exercise, it is apparent that the same issue that was present when inspecting the monetary expenditure values recurs. Figure 5.2 illustrates that a trend among average values indicates a positive linear trend in relation to time passing by, while the median values indicate a gradual decrease or negative linear relationship to time passing by. Due to having a rather limited number of participants within the study, it should be stated that the median values trend line is understood to be a more accurate reflection of what behavioural trend is occurring in the group as a whole. Additionally, it is interesting to note that the gradient of the median trend line regarding the carbon emissions appears to be less severe when compared to the gradient of the median monetary expenditure trend line.

Figure 5.3 and Figure 5.4 were developed to illustrate the overall average and median number of kilometres travelled by participants for each day of the research exercise period; the underlying data behind both figures can be examined in greater detail in Addendum I: Daily Kilometres Travelled by Participants during the Research). Figure 5.3 shows that the average daily distance travelled was just under 50 km. Using this figure, it can therefore be deduced that, on average, the participants lived less than 25 km away from their place of work.

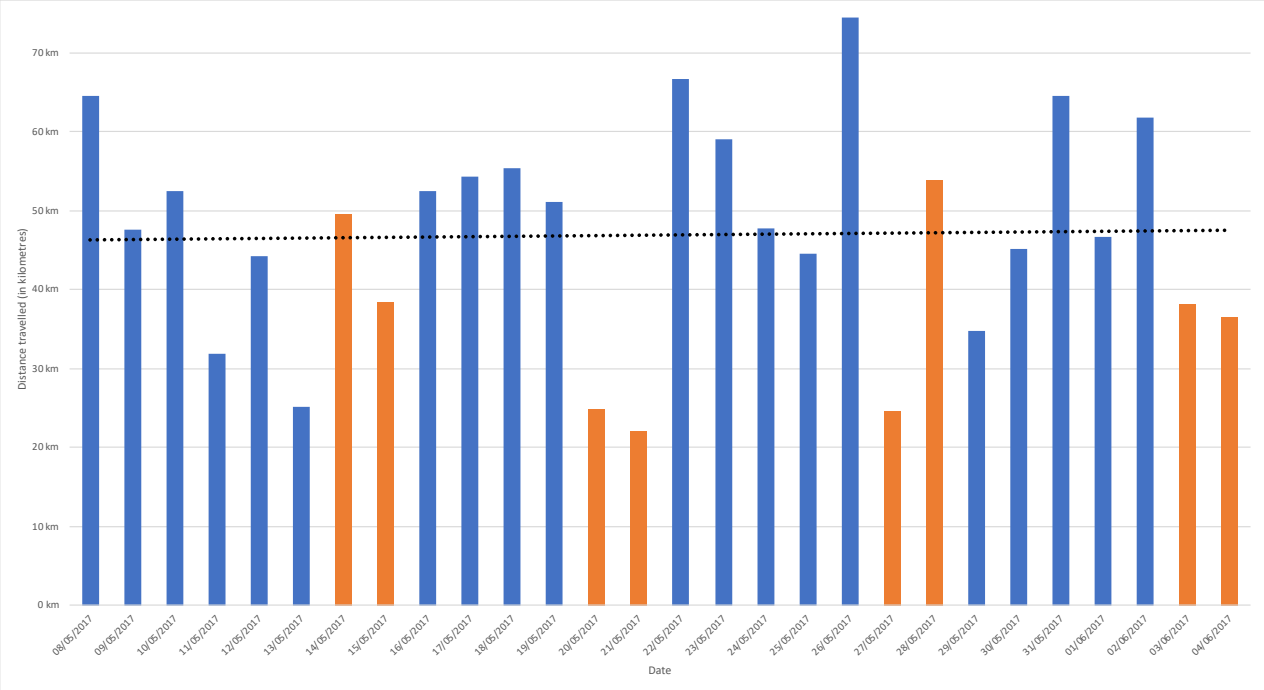

Figure 5.3: Average number of kilometres driven by participants during the research exercise

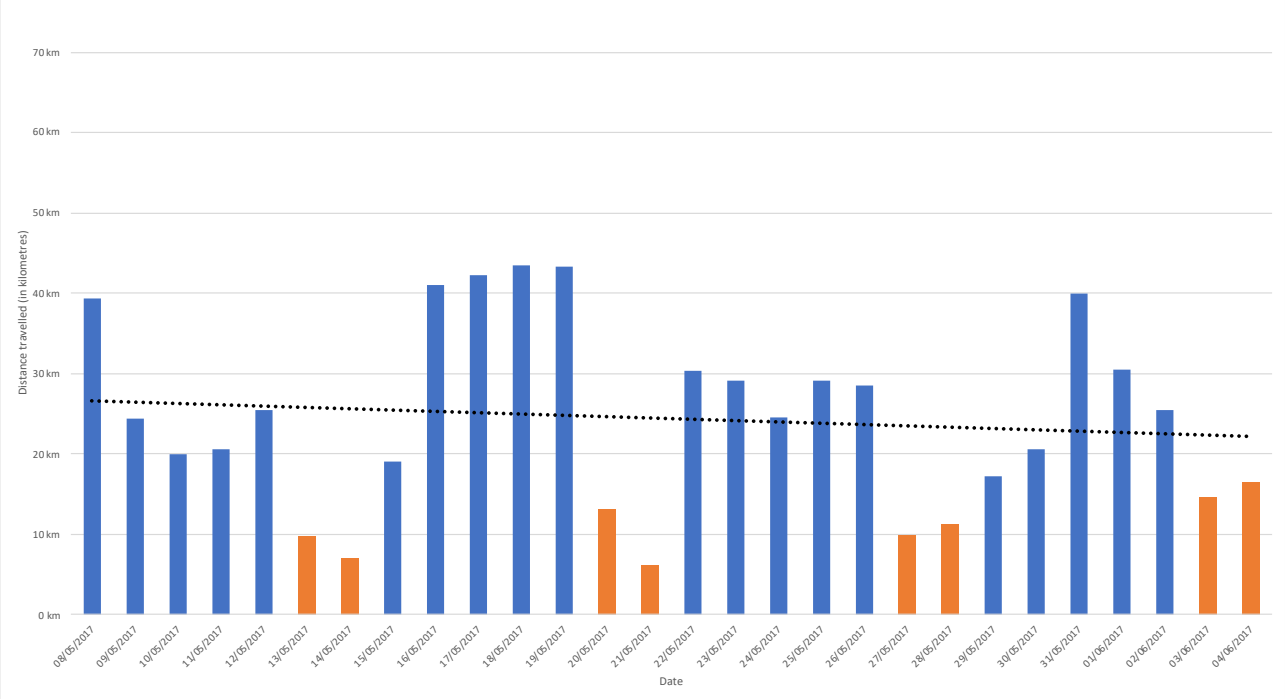

Figure 5.4: Median number of kilometres travelled by participants during the research exercise

The blue bars in the figures above illustrate weekdays (typically working days), while the orange bars illustrate weekends (typically non-working days). In general, when comparing Figure 5.3 and Figure 5.4, a few elements become apparent. Due to the graphs both containing the same format and scales, the difference in average number when compared to median number becomes apparent. In general, the average number of kilometres driven is substantially higher compared to the median number. Median travel distances over the weekends were found to be significantly lower than weekday distances. The final noteworthy difference identified between the two figures is that in Figure 5.3 the trend of values (average values) appears to be positive and therefore average daily distance travelled is seen to increase slightly as time goes on; whereas in Figure 5.4, the trend of values (median values) is negative and thus the median daily distance travelled decreases as time goes on. This could once again be due to certain participants (who could be viewed as outliers) who skewed the average values to increase toward the later stages of the research period.

Once again, the data in the two figures fail to hold any statistical significance when attempting to understand the linear relationship these two sets of data have regarding time while performing a regression analysis. This, as previously mentioned, is possibly due to the low number of participants and relatively short time period in which the research study took place.

5.6.2 Investigation into time spent in vehicles

The data captured by the various GPS devices allowed for the collection of various timestamp as well as location data, such as street names. Due to this information, given that individuals often park their cars in the same general area when arriving at home, it was possible to ascertain where the individuals resided and thus determine when the vehicles were parked at or near their places of residence. However, due to many of the individuals being consultants who often worked out of office, it was difficult to determine when they were at their official places of work.

Therefore, when analysing the data, three separate groupings in terms of time spent throughout the week were identified. These groupings were categorised as (1) time spent at home, (2) time spent away from home (or other), and (3) time spent travelling. Table 5.11 shows the time data relating to each participant with relevance to the sets of locations and activities.

Table 5.11: Time summary data for each participant during the research exercise period of study (H: M: S)

Device number	TIME SPENT AT HOME PER WEEK				TIME SPENT AT OTHER PER WEEK				TIME SPENT TRAVELLING PER WEEK			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
TBI 1	118:10:00	99:28:00	114:38:00	113:03:00	44:15:00	56:35:00	45:46:00	44:55:00	05:35:00	11:57:00	07:36:00	10:02:00
TBI 2	113:13:00	95:50:00	132:14:00	123:50:00	45:28:00	62:14:00	29:01:00	36:59:00	09:19:00	09:56:00	06:45:00	07:11:00
TBI 3	108:29:00	120:50:00	127:30:00	123:51:00	53:13:00	41:01:00	32:42:00	38:05:00	06:18:00	06:09:00	07:48:00	06:04:00
TBI 4	118:32:00	124:44:00	69:55:00	33:40:00	41:26:00	36:09:00	83:21:00	126:57:00	08:02:00	07:07:00	02:44:00	07:23:00
TBI 6	83:55:00	68:45:00	68:33:00	55:34:00	73:49:00	89:41:00	80:11:00	107:35:00	10:16:00	09:34:00	07:16:00	04:51:00
TBI 7	103:00:00	90:08:00	104:56:00	102:06:00	57:26:00	68:52:00	55:28:00	58:30:00	07:34:00	09:00:00	07:36:00	07:24:00
TBI 8	110:40:00	114:10:00	131:42:00	137:10:00	48:29:00	49:17:00	32:33:00	26:59:00	08:51:00	04:33:00	03:45:00	03:51:00
TBI 9	99:53:00	141:56:00	113:59:00	122:44:00	64:30:00	24:52:00	51:34:00	41:47:00	03:37:00	01:12:00	02:27:00	03:29:00
TBI 10	114:47:00	107:36:00	109:42:00	146:47:00	47:14:00	55:53:00	51:06:00	17:51:00	05:59:00	04:31:00	07:12:00	03:22:00
TBI 11	115:23:00	99:01:00	116:51:00	110:02:00	46:57:00	61:18:00	42:47:00	49:58:00	05:40:00	07:41:00	08:22:00	08:00:00
TBI 12	74:55:00	90:36:00	94:59:00	96:41:00	80:32:00	67:58:00	58:53:00	55:19:00	12:33:00	09:26:00	02:08:00	04:00:00
TBI 13	86:54:00	101:31:00	121:08:00	143:40:00	71:53:00	62:51:00	43:51:00	22:42:00	09:13:00	03:38:00	03:01:00	01:38:00
TBI 14	127:57:00	55:11:00	89:48:00	56:25:00	35:55:00	102:12:00	61:22:00	94:52:00	04:08:00	10:37:00	04:50:00	04:43:00
TBI 15	144:21:00	128:28:00	137:17:00	111:31:00	15:54:00	34:13:00	28:24:00	52:23:00	07:45:00	05:19:00	02:19:00	04:06:00
TBI 16	114:36:00	100:54:00	110:47:00	162:04:00	46:26:00	59:59:00	39:20:00	5:05:00	06:58:00	07:07:00	05:53:00	12:51:00
TBI 17	99:12:00	99:25:00	82:38:00	68:43:00	59:30:00	60:48:00	76:39:00	92:06:00	09:18:00	07:47:00	08:43:00	07:11:00
TBI 18	117:50:00	124:57:00	111:31:00	106:40:00	37:23:00	31:08:00	44:56:00	50:27:00	12:47:00	11:55:00	11:33:00	10:53:00
TBI 20	86:55:00	114:04:00	112:16:00	138:09:00	72:13:00	47:32:00	49:14:00	22:16:00	08:52:00	06:24:00	06:30:00	07:35:00
TBI 21	103:15:00	70:09:00	126:41:00	14:11:00	60:30:00	86:39:00	31:59:00	145:12:00	04:15:00	11:12:00	09:20:00	08:37:00
GPS 1	90:56:05	96:20:57	138:50:05	135:50:42	67:07:25	67:09:10	23:23:11	25:32:45	09:56:30	04:29:53	05:46:44	06:36:33
GPS 2	140:42:10	123:42:10	103:22:20	135:46:44	19:01:11	35:30:35	54:33:35	22:27:35	08:16:39	08:47:15	10:04:05	09:45:41
GPS 3	146:17:09	157:00:14	109:15:59	129:29:21	18:01:55	7:20:26	48:51:40	32:11:44	03:40:56	03:39:20	09:52:21	06:18:55
GPS 4	117:48:06	131:36:49	126:51:25	118:32:47	44:22:03	30:51:39	34:49:21	41:51:39	05:49:51	05:31:32	06:19:14	07:35:34
SUM	**2537:40:30**	**2456:23:10**	**2555:24:49**	**2486:30:34**	**1151:35:34**	**1240:03:50**	**1100:44:47**	**1212:01:43**	**174:43:56**	**167:33:00**	**207:50:24**	**165:27:43**
AVERAGE	**110:20:01**	**106:47:58**	**111:06:18**	**108:06:33**	**50:04:09**	**53:54:57**	**47:51:31**	**52:41:49**	**7:35:49**	**7:17:05**	**9:02:11**	**7:11:38**
MEDIAN	**113:13:00**	**101:31:00**	**112:16:00**	**118:32:47**	**47:14:00**	**56:35:00**	**45:46:00**	**41:51:39**	**7:45:00**	**7:07:00**	**7:48:00**	**7:11:00**

The amount of time spent at each location or activity per private vehicle identified by the device number can be viewed, as well as the total time spent for each week. The average and median values for the week are represented at the bottom of Table 5.11.

Overall, it was found that the participants' time at home and at other locations fluctuated during the four-week period when inspecting the average and median values. However, the amount of time spent travelling remained fairly constant, i.e. between seven and eight hours per week for both average amounts and median amounts, except for the average amount of travel time found in Week 3, which was found to be around nine hours, and for the purposes of this study will be treated as an outlier.

Therefore, when inspecting the average and median values, it can be assumed that the participants utilised their vehicles for slightly more than one hour per day. To better illustrate how individuals spent their time per day, Figure 5.5 conveys the average daily time values found during the four-week period, whereas Figure 5.6 illustrates the median daily values.

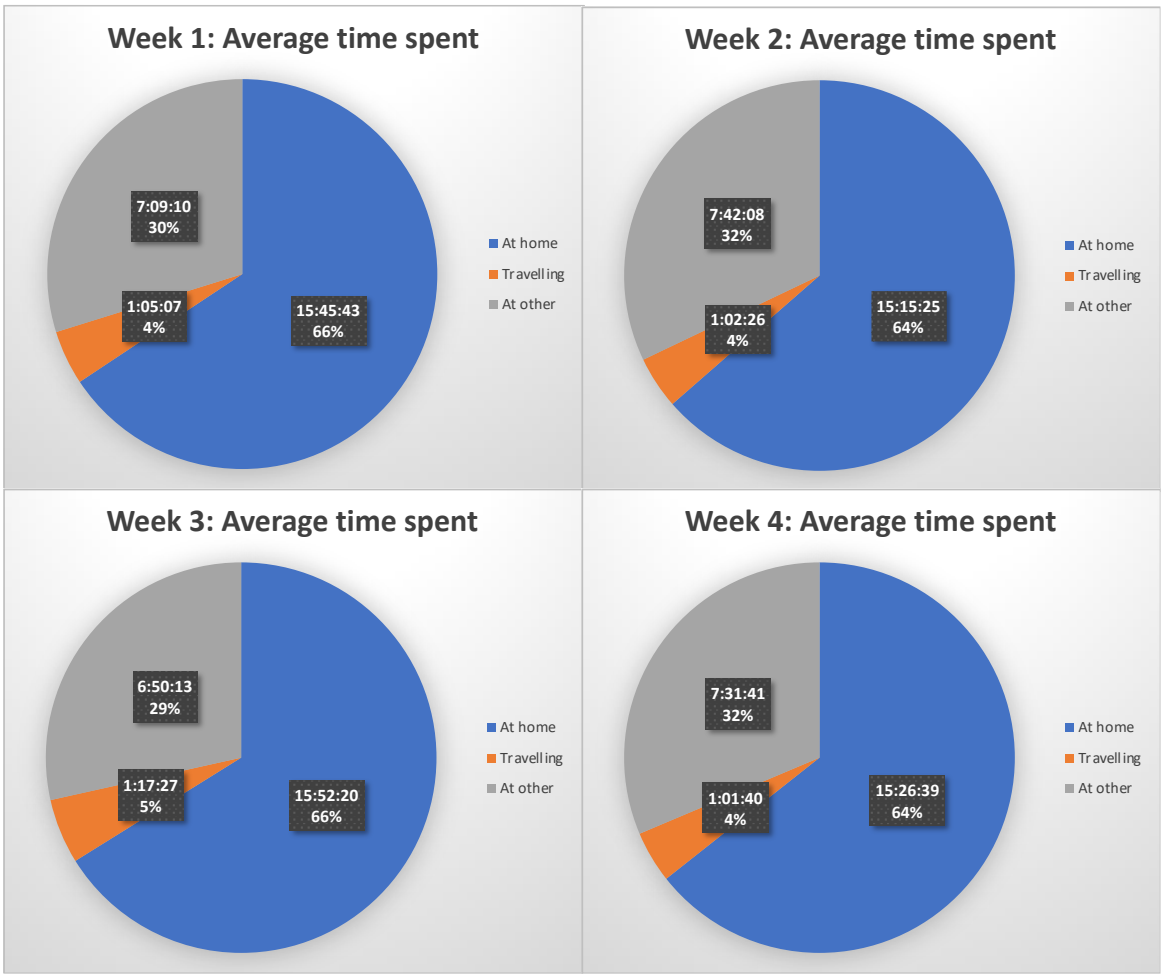

Figure 5.5: Average time spent at activities during research exercise period

As can be seen in Figure 5.5, participants spent on average 15 hours 45 minutes and 43 seconds at home per day during Week 1, or 66% of their time per day was spent *at home*. The average values

also illustrate that, on average, a participant would travel for an average 1 hour 5 minutes and 7 seconds, or 4% of their daily time during Week 1. The remainder of their time, 7 hours 9 minutes and 10 seconds, was spent away from home, at *other locations*, which translates roughly to 30% of their time per day.

When investigating the range regarding the average amount of time participants spent across activities on a daily basis, the values are as follows: a range of 15 hours 15 minutes and 25 seconds (64%) to 15 hours 52 minutes and 20 seconds (66%) for time spent at home, and a range of 6 hours 50 minutes and 13 seconds (29%) to 7 hours 42 minutes and 8 seconds (32%) for time spent out of home (at other locations). Finally, the range of values for average travel time was found to fall between 1 hours 1 minute and 40 seconds (4%) and 1 hour 17 minutes and 27 seconds (5%). Travel time appears to be more inelastic, while the other variables appear to be substitutes for one another regarding the shifting of time spent during activities. Figure 5.6 follows the same format as Figure 5.5; however, it conveys the median time values per activity across the four-week period. It should be noted that due to Figure 5.6 illustrating the median time values, totals for the period will not add up to 24 hours as per the average values analysed.

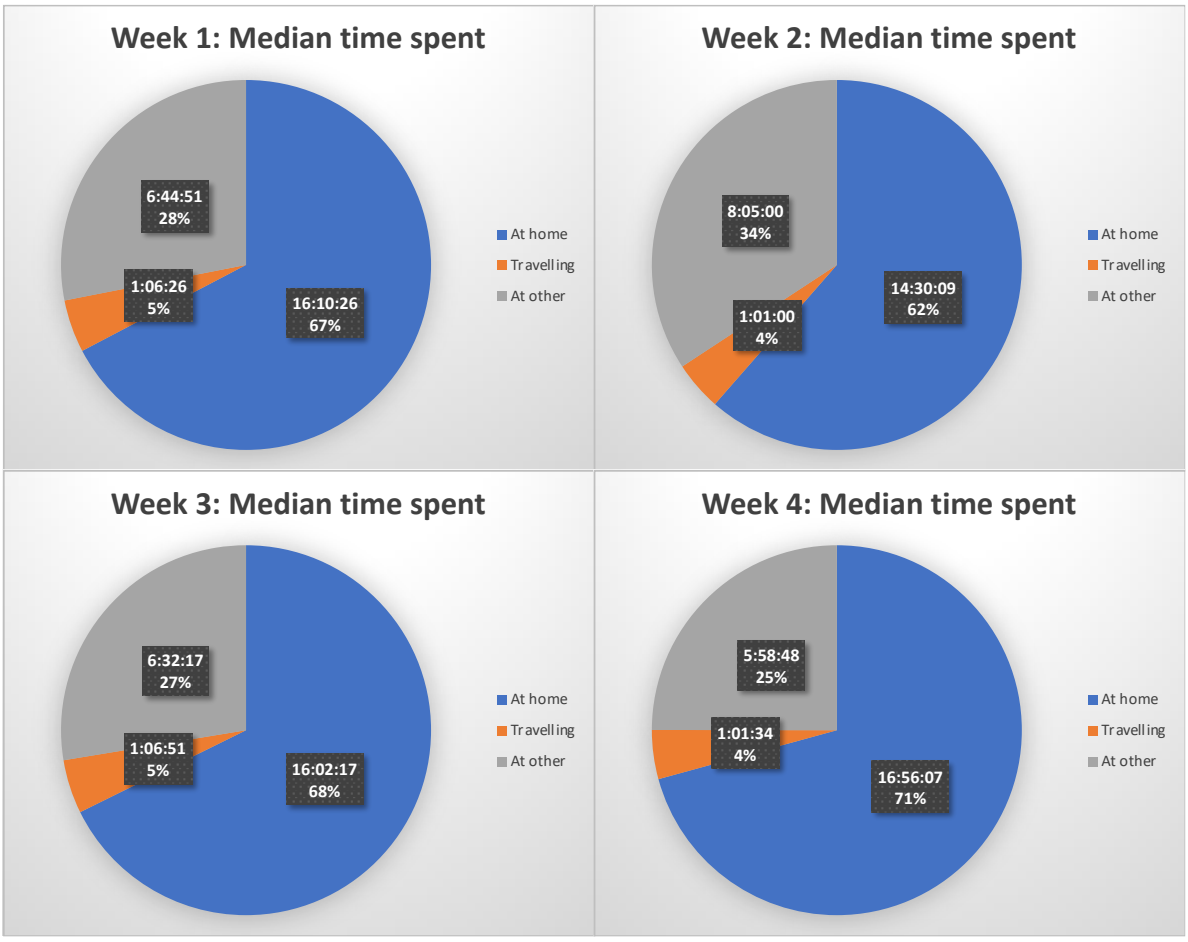

Figure 5.6: Median time spent at activities during research exercise period

Investigating the median values of how participants spent their time revealed a similar finding to the average values. The range of values regarding median time amounts spent across the various activities followed a similar profile where time spent traveling appeared to be relatively inflexible when compared to the other two activities.

Once again it should be noted that these values were converted to illustrate the amounts of time used per "activity" for the average day (24 hours). Given that the locations of participants' homes and places of work remain fixed, time spent travelling could be defined as a combination of distance regarding these locations, the transport mode utilised, and the transport network utilised; these aspects remain relatively inflexible during the short term. Therefore it stands to reason that the only variable that could impact time spent travelling is speed of travel; however, transport network congestion limits this. Therefore, it can be stated that in the short term, the participants' time spent travelling was relatively fixed. This is validated by the fact that when comparing the range of values for time spent travelling during this research study, the participants expressed a daily range of less than 20 minutes for average time values and less than six minutes for median time values.

Given that a change in the amount of time spent travelling was not recorded during the tracking period, an investigation is now made with the focus on measuring a possible change in when the participants chose to travel. By utilising daily data, it was possible to determine when the participants made their first and last trips of the day. Figure 5.7 presents two graphs. The graph on the left illustrates the average time that the participants made their first and last day trips, while the graph on the right illustrates the median values relating to the first and last trip of each day for the participants.

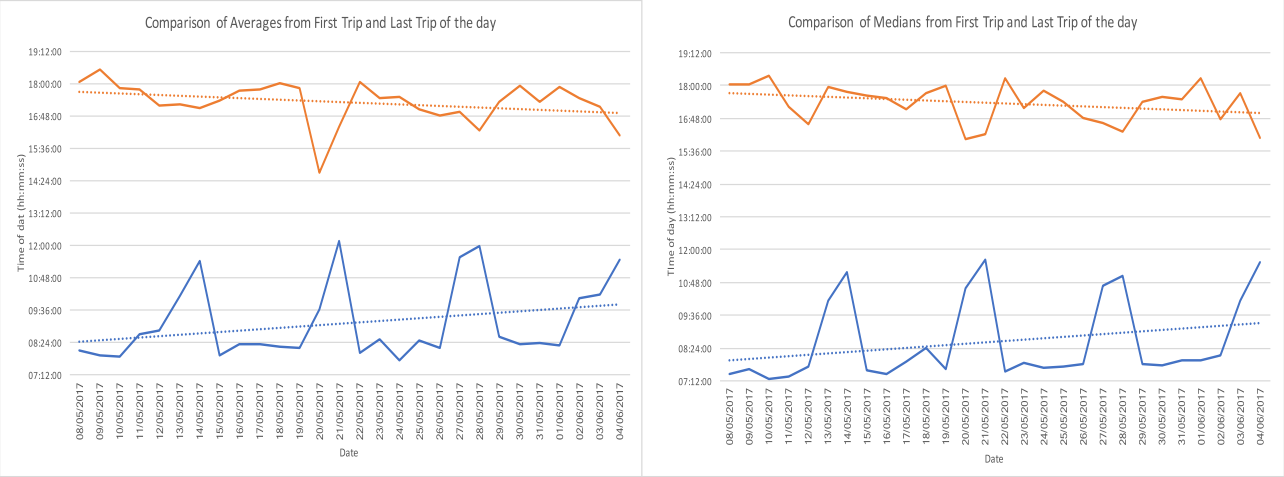

Figure 5.7: Comparison of average and median values of when participants made their first and last day trips

In Figure 5.7, both sets of graphics were plotted on the same axis values in order to assist in the comparison of data. The solid blue line represents the first trip of the day, whereas the solid orange

line represents the last trip of the day. The dotted lines represent the overall trend obtained from the data and are simply used as a method to easily identify the current trend.

From Figure 5.7 it can be seen that as time progressed, the participants began adjusting their travel behaviour in relation to when they left in the morning and when they returned in the evening for both the average dataset and the median dataset. Both datasets indicate that the individuals would begin to leave later in the morning and return earlier in the afternoon. Even though the datasets portray slightly different times relating to when the participants left and returned, the overall trend for both datasets appears to have the same gradient and therefore complement each other regarding the findings. The spikes visible in both datasets relating to the average time and median time of first trip per day are illustrative of the times that the participants would first drive during the weekends. This behavioural trend is fairly expected as it illustrates that individuals left later in the morning on weekends than weekdays.

When investigating whether time of travel per day holds any significant statistical relationship with regard to the progression of the research exercise, it was found that none of the data presented held any statistical relevance. This is believed to be due to the weekend data that may have influenced the findings, in addition to the low number of participants and the short tracking period.

When removing the weekend data from the datasets and investigating whether there was any statistically significant relationship, it was found that the median value time for the first trip per day was statistically significant. Therefore, it can be concluded that as time progressed throughout the research study, the participants were, in terms of median values, found to progressively postpone/delay their first trip per weekday.

5.6.3 Investigation into the number of trips during the research exercise

The third and final set of data that was collected by the GPS devices comprised the number of trips undertaken during the research exercise period. To begin the investigation, the number of trips taken per week is examined. Following this, the number of trips the participants undertook per day is investigated.

Table 5.12: Number of trips undertaken by participants per week

Device Number	NUMBER OF TRIPS TAKEN PER WEEK			
	Week 1	Week 2	Week 3	Week 4
TBI 1	27	49	40	43
TBI 2	32	32	39	30
TBI 3	25	15	33	15
TBI 4	21	17	32	19
TBI 6	41	37	39	16
TBI 7	38	39	40	41
TBI 8	46	32	32	31
TBI 9	35	11	16	27
TBI 10	18	20	21	8
TBI 11	43	35	35	52
TBI 12	51	32	44	62
TBI 13	31	20	16	8
TBI 14	18	28	40	38
TBI 15	28	27	20	21
TBI 16	14	16	9	4
TBI 17	27	22	26	27
TBI 18	39	44	35	42
TBI 20	16	13	20	16
TBI 21	22	46	34	23
GPS 1	24	22	26	30
GPS 2	27	23	30	12
GPS 3	11	19	28	21
GPS 4	18	19	19	24
SUM	**652**	**618**	**674**	**610**
AVERAGE	**28.35**	**26.87**	**29.30**	**26.52**
MEDIAN	**27**	**23**	**32**	**24**

Table 5.12 displays the number of trips undertaken by each participant for each week of the research period. The bottom three rows illustrate the total number of trips, the average amount, and the median value of trips undertaken per week. In summary, the total number of trips per week ranged from 618 to 674 trips, the average number of trips ranged from 26.5 to 29.3 trips, and the median number of trips undertaken ranged from 23 trips to 32 trips per week.

Figure 5.8 was created in order to investigate whether any trend was possibly present according to the weekly data. Figure 5.8 utilises the average and median data derived from Table 5.12 in order to illustrate the overall findings of the data.

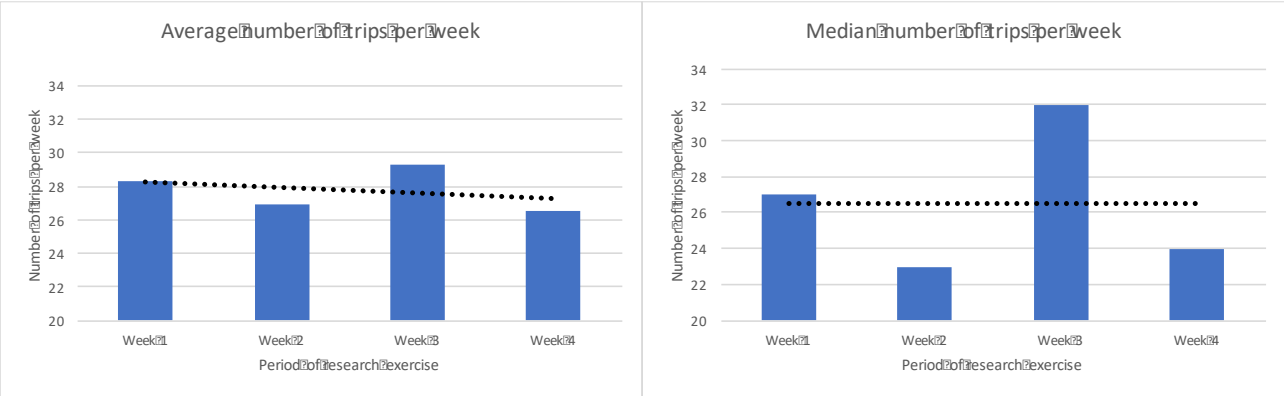

Figure 5.8: Average and median number of trips undertaken per week

In Figure 5.8, two graphs are presented; the graph on the left represents the average number of trips undertaken per week, and the graph on the right represents the median number of trips undertaken per week. Both sets of graphs were formatted to utilise the same axis to make comparisons more consistent. In the left graph, the trend, illustrated by the black dotted trend line, indicates that the individuals took fewer trips as the study period progressed. However, when investigating the median values for number of trips undertaken per week, it appears that a trend is not present, as the median trend fails to indicate a gradient. This discrepancy could be due to the relatively high median number of trips that is found to be present in Week 3 of the research exercise period. This discrepancy encourages further investigation into the average and median number of trips undertaken by the participants during the study period.

In order to attain a better understanding of whether a trend is present within the data relating to the number of trips undertaken, more detailed data are required. Figure 5.9 shows the daily number of trips undertaken by the participants in terms of average and median values.

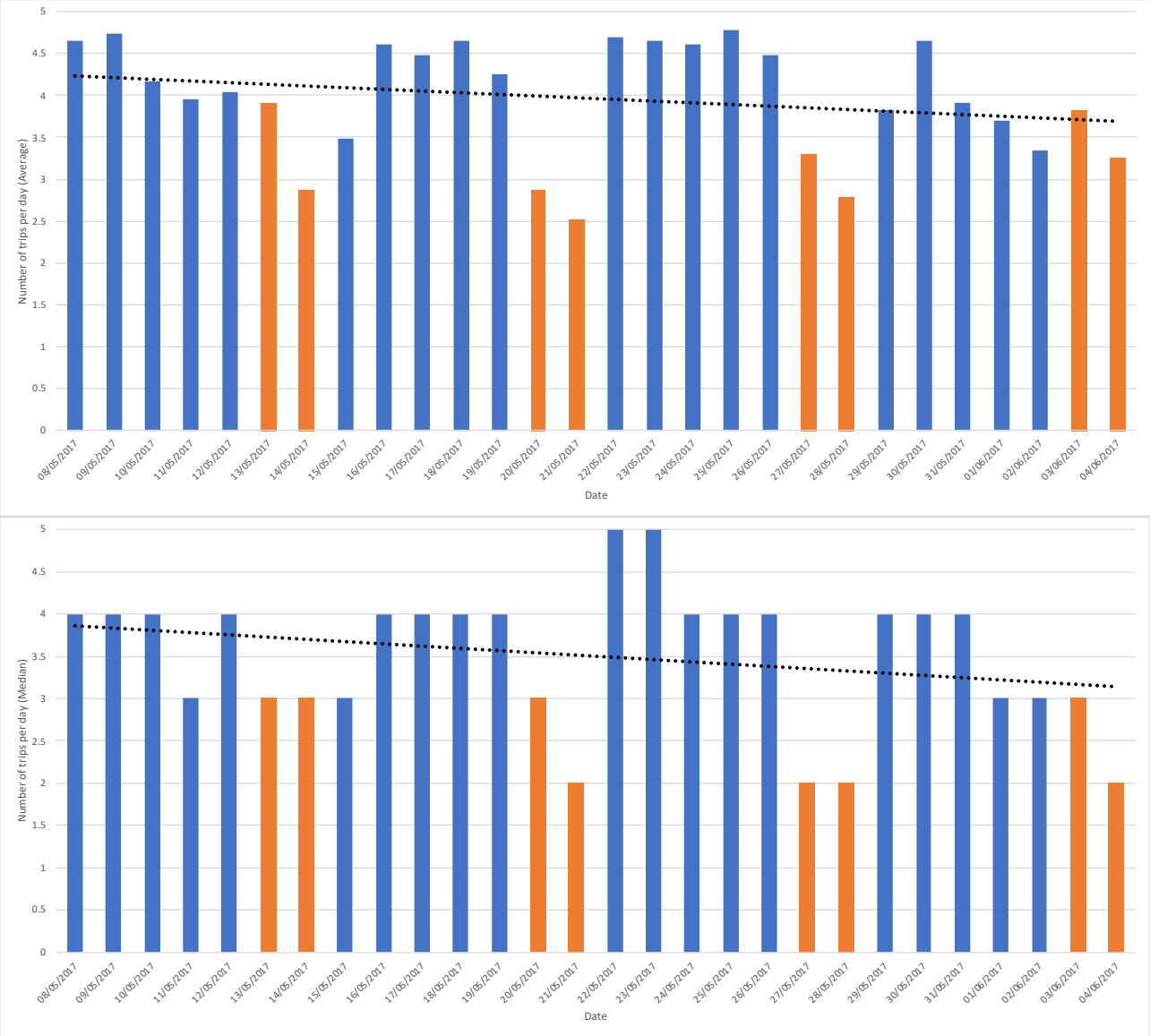

Figure 5.9: Average and median number of trips undertaken per day

Figure 5.9 illustrates two datasets. The top graph represents the daily average number of trips undertaken during the research study, while the bottom graph illustrates the median number of trips undertaken by the participants per day. Both graphs have the same axis formatting, and the dates that represent weekends are indicated by orange bars, whereas weekdays are indicated by blue bars.

From these graphs it is derived that both datasets appear to hold similar trends that illustrate that there was a decrease in the number of trips undertaken by participants as the study progressed over time. Unfortunately, when investigating the statistical significance of this relationship, the relationships for both datasets fail to illustrate statistical significance.

Due to a lack of statistical significance present, an investigation was made, similar to the one made regarding travel time of day, to understand whether there was possibly any relationship between the number of trips undertaken, during weekdays only, and time as the study progressed.

Unfortunately, no statistically significant relationship was found to be present for the average or median number of trips undertaken by the participants during the study.

5.7 SUMMARY OF FINDINGS

To begin this summary section, it should be reiterated that due to the relatively small sample size of 23 participants, and because the study period took place over a relatively short period of time (four weeks), any identified differences could not be proven to be statistically significant for the population as a whole. Therefore, any discussion regarding trends and potential pattern identification should be taken lightly.

This chapter began by investigating the responses to the first questionnaire (pre-research exercise) to discuss the demographics of the participants who took part in the study. Thereafter, the responses from the first questionnaire were compared to the responses from the second questionnaire (post-research exercise). From this it was found that, of the 19 participants who completed both questionnaires, the cost estimations per kilometre increased by an average of 52 cents per kilometre, which translates to an increase of around 27% after being exposed to the informational invoices. Similarly, all three disutilities associated with transportation had a higher perceived impact on the participants' lives (with time disutility increasing the most).

When investigating the shifts of responses by gender type, it was found that women increased their cost estimates substantially more than men did (an increase of R1.07 per km vs R0.12 per km). Their perceptions regarding transport disutilities also increased across the board, by a value of around 1, whereas men experienced marginal changes in perception regarding transport disutilities. When investigating the shifts of responses for different age groups, one notable difference was that younger individuals had a reduced perceived monetary disutility (-0.25), whereas older participants had an increased perceived monetary disutility (+0.82).

The participants who indicated that they drove fewer times per week experienced a decrease in perceived time disutility (-0.43), while those who used their vehicles more frequently experienced an increase in time disutility (+1.50). This difference could potentially be explained by participants previously not truly understanding how much time they actually spent using their private vehicles and the information provided during the research exercise assisting in informing them of the actual time spent driving, which shifted their relative perceptions.

Both carpooling and non-carpooling individuals had an increase in cost estimates; however, estimates for carpooling individuals increased less (R0.07 vs R0.73 per km). This could potentially be due to carpooling individuals being able to share the costs associated with travel. However, when

investigating the shift in perceptions, carpooling individuals experienced a greater perceived disutility across the board, whereas the shift in perceptions for individuals who did not carpool was marginal.

Changes in perceptions and estimates regarding participants who dropped off others versus those who did not were fairly similar, except for perception of time and other disutility factors, where those who dropped off others indicated a major increase in time and other perceived disutility after the research exercise. This could be due to these individuals internalising the amount of time spent when dropping off others during their commute.

When investigating the driving statistics captured by the GPS devices with regard to various demographics, it was found that participants who carpooled and those who dropped off others tended to drive shorter distances on average compared to those who did not. This could potentially be explained by assuming that the individuals who carpooled would only be in the situation to do so if the drop-off and collection points were already en route and they themselves were found to be on a commonly used road and not particularly "out of the way".

When investigating the driving statistics captured by the GPS devices with regard to various vehicle characteristics, it was found that the vehicles with the biggest engine size drove the shortest distances and were also used for the shortest periods of time. This is probably due to big engines usually being associated with higher running costs, which caused the participants to use their vehicles more sparingly in order to save on costs. In contrast, the most expensive vehicles within the study group were found to drive the longest distances and were utilised for longer times on average. This could be as a result of participants choosing to purchase these expensive vehicles due to having the knowledge that their jobs require them to drive long distances. These participants therefore purchased more expensive vehicles as these are usually associated with greater levels of comfort and convenience.

When investigating the travel behaviour patterns of the participants over the course of the four-week study period, it was found that the average and median trend values regarding distance driven were contradictory (as average values would increase with time and median values would decrease). This was most likely due to a few potential outliers that skewed one of the datasets, and due to the relative small sample size, these outliers could be isolated successfully.

When investigating the amount of time that individuals utilised their private vehicles, it was found that time spent driving remained relatively inflexible (taking up 4-5% of total daily time). This could be explained due to individuals having to travel between their place of residence and employment, which in the short term caused them to be relatively "fixed" or "stuck" in a particular travel behaviour pattern. Therefore, time spent at home and time spent at other places were in essence substitutes for

each other. However, it was found that as time progressed throughout the study, individuals were found to take their first trip later in the day and undertake their last trip earlier in the day. This could be an indication that the individuals were attempting to adjust their travel behaviour patterns so that more time could be spent at home.

The analysis of the number of trips taken by the participants during the research exercise indicated a trend, where fewer trips were being taken as time progressed for average and median daily values. These findings, however, were unfortunately not found to be statistically significant through regression modelling. This is a potential indicator that individuals were attempting to adjust their travel behaviour patterns.

CHAPTER 6:
CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

In the introductory chapter of this research study it was expressed that private vehicle users do not take the costs associated with private vehicle transportation fully into consideration, or that they do not fully understand the costs associated with their mode of transport. As a result, the primary aim of this research study was to, through the process of a research exercise, develop and test a new TDM technique, with the main focus on the utilisation of informational/educational measures to influence travel behaviour. The measure created and tested was planned to convey the combined personalised monetary cost associated with private vehicle transportation, as well as the environmental impact information of private vehicle usage. Any subsequent alterations in travel behaviour caused by the sharing of information were monitored in order to understand whether the TDM measure achieved the desired effect. It can therefore be stated that the aim of this dissertation was achieved; further details regarding the implementation of the TDM measure can be viewed in Chapter 3.

The objectives outlined in the study were to first and foremost investigate whether the actual monetary costs experienced differed from the perceived costs that individuals generally associate with private vehicle transportation. In the literature review of this research study it was found that these costs do indeed vary. Malecki (1978) found that individuals do not correctly perceive the running costs associated with private vehicle utilisation. Similarly, Borg (1982) found that individuals do not consider all the costs associated with private vehicle utilisation and, as such, the omitted elements play a crucial role in their misunderstanding of how total actual vehicle monetary costs are achieved. These findings were further compounded by the fact that Janicki (2015) found clarification on the matter when individuals were surveyed in an attempt to collect information regarding their perceived and actual private vehicle monetary costs, and it was found that students in general perceived the monetary costs of private vehicles to be around 65% of the actual costs incurred.

Following the completion of the first objective, the next objective aimed to investigate possible methods in which environmental costs associated with private vehicle usage could be quantified. In addition, once a method of quantification was established, a method of making these quantified values understandable to the average vehicle user needed to be determined. As such, the method of quantifying the environmental impact of vehicle usage was derived from a formula utilised by the New Zealand government, which takes the fuel consumption of a private vehicle, the fuel consumed, and the overall utilisation of the vehicle into consideration in order to determine the amount of CO_2

that is emitted (New Zealand Transport Agency, 2016). Following this, the amount of emissions produced is converted into the amount of trees that would need to be planted in order to absorb the CO_2 and thus make the distance travelled carbon neutral (Arbor Environmental Alliance, 2008). Finally, the cost of planting these trees in order to make participants carbon neutral was calculated and relayed to the participants in order to assist them in understanding the financial impact of their environmental pollution (Carbon Neutral Pty Ltd, 2015).

The next objective was to investigate whether it is possible to collect, monitor, and extract the required information and data needed in order to ascertain what the actual monetary and environmental information relating to real-world travel behaviour would be. In order to complete this objective, two methods of data collection were utilised. First, an online survey was utilised in order to collect information regarding the characteristics of the vehicles that the participants utilised. This was done so that the AA rates could be linked to each participant's vehicle, which assisted in understanding how much monetary expense respective owners experienced at a per kilometre rate. The information gathered from the online survey was additionally utilised in order to understand the fuel type that each participant used for their vehicle, and an estimation of the fuel consumption was made by investigating the engine size of the vehicle utilised. This information was captured in order to estimate the overall CO_2 emissions that would be created per kilometre of vehicle utilisation. The second method of data collection required the collection of travel behaviour data. These data needed to be collected with relative ease while maintaining the accuracy of the collected data. As such, the utilisation of GPS devices offered the optimum solution. The GPS devices allowed the researcher to collect travel behaviour data from online servers, which meant minimal intrusion for the participants while the researcher was simultaneously able to review live data and monitor any technical issues that may have occurred during the research exercise.

The installation of GPS devices in the private vehicles of the individuals who took part in the study also allowed for the next objective to be attained. This objective entailed being able to collect data in order to investigate whether any alteration in travel behaviour did indeed occur due to the TDM intervention technique. The GPS devices allowed for the monitoring and collection of travel behaviour data throughout the research exercise. Due to this, the travel data were able to be analysed and the results and findings were discussed in Chapter 5 of this research study. Unfortunately, due to the research sample size being relatively small, as well as due to the fact that there may have been external influences affecting the travel behaviour of the participants, it is difficult to deduce whether any changes in travel behaviour were indeed due to the personalised informational invoices created for and distributed to individuals who took part in the study. However, it must be stated that the GPS devices, which utilised the GSM network in order to relay data and which were installed directly into

the private vehicle of the participants, appeared to be the most convenient and accurate method of collecting travel behaviour data for a research study such as this one.

The final objective outlined in Chapter 1 of this research study was to identify whether an alteration in travel behaviour was realised as a result of the proposed TDM measure. As mentioned above, due to the small sample size, it was not possible to derive results that were statistically significant. Due to this, a second dataset was sourced in hopes of deriving a better understanding of which population subsets may be more likely to alter their travel behaviour when presented with certain motivational drivers. Unfortunately this, which can be found in Chapter 4, was unable to find relationships which held a statistical significance of a satisfactory nature. However, in an attempt to better understand the alterations of travel behaviour during the research exercise, an investigation into the various demographics, as well as other characteristics relating to the participants and their vehicles, attempted to deduce findings or indications that could potentially be used in further studies. A full discussion and investigation relating to these findings can be found in Chapter 4 and Chapter 5; however, some interesting findings are discussed here.

It should firstly be noted that there is a possibility that the participants who completed the tracking exercise may have either not read the emails sent to them regarding their informational invoices or perhaps did not fully understand the information presented to them. As such, any result or findings alluded to, or lack thereof, may in fact potentially be due to some external variables that were not taken into account. In addition, throughout the findings of this research exercise, there is a consistent thread present that suggests that the data collected and any trends investigated appear to lack any statistical significance. There are three main possibilities that have come to the researcher's attention regarding the reason for this lack of statistical significance. Firstly, the sample size of this research exercise was simply too small and thus makes it challenging to find any statistical relevance when attempting to understand a regression analysis. Secondly, the study period of the research exercise (four weeks) was too short to uncover any definitive alteration in travel behaviour. Thirdly, perhaps the research study did not have the intended impact that was hoped for. In the case of the third scenario, any findings illustrated in this research paper should be taken with a pinch of salt and the recommendations that follow the conclusion should thus be taken into account regarding any further studies on the matter.

When investigating the perceptions and estimates that individuals had prior to the research exercise, and comparing them to the perceptions and estimates that individuals had after the research study, overall there appeared to be an increase in the estimated cost per kilometre that participants felt their vehicles incurred. In addition, the relative impact of the disutilities associated with private transportation increased on average for the participants. One truly notable change that could be found

regarding the change in perception pre- and post-research exercise appeared to be the fact that women on average experienced a much greater increase in estimations of costs associated with their private vehicles per kilometre than men. On average, women increased their estimation of costs to be R1.07 more expensive per kilometre after the research exercise, while the average man's estimation of costs associated with private vehicle expenditure only increased by 12 cents. As mentioned previously, any findings within this study may potentially have multiple reasons due to the fact that individuals generally underestimate their costs associated with private vehicle transportation. One of these reasons may be that women were found to be more impressionable with regard to informational invoices.

Due to the fact that individuals generally underestimate their costs associated with private vehicle transportation, it is assumed that the increase in estimation of costs for the participants brings them closer to the actual values incurred. Therefore, in the case of the difference of estimations increasing between men and women, it is possible that due to women originally estimating the costs associated with private vehicles to be much lower than men on average, their large increase simply negates the original difference. If this were the case, the values found from Questionnaires 1 and 2 can be utilised to investigate what the change in perception could potentially mean. In Questionnaire 1, men estimated the costs of private vehicle usage to be on average R2.28 per kilometre, whereas women estimated these costs to be around R1.43 per kilometre. Taking the increase in estimates into consideration, men estimated the costs associated with private vehicle transport to be R2.40 per kilometre (R2.28 + R0.12) on average after the research exercise, whereas women estimated the costs to be R2.50 per kilometre on average (R1.43 + R1.07). The fact that these values more closely relate to one another could be a strong indication that the informational monetary invoice assisted in aligning the average estimated costs per kilometre for the participants. Another potential reason for the drastic change in estimation is perhaps due to women being more receptive to educational influences, such as the informational invoices utilised in this research study, than men. The final potential reason for this discrepancy is that it is possible that whereas women received and read the monetary cost invoices, men discarded the invoices and did not give the invoices as much detailed attention.

Additional findings and results from Chapter 5 that can be highlighted relate to the data captured by the GPS devices. The data that were captured by these devices primarily related to the distance each participant travelled with their private vehicle, the amount of time that participants utilised their vehicle, and the number of trips that the participants took with their private vehicles. With regard to the distance that participants travelled over the four-week research exercise period, it was found that there was a general decrease in kilometres driven as time progressed when investigating the median

values of the participants. When investigating the average number of kilometres driven, however, an increase in average kilometres driven per day was found to be present. Unfortunately, no statistically significant relationship for either of the values was found to be true in relation to the progression of time. A potential reason for the difference in trends may have been due to one or two outliers that significantly influenced the average values and were thus not taken into consideration when investigating the median values.

The next variable measured in terms of travel behaviour was the amount of time that participants spent utilising their vehicles per day. In order to understand the utilisation periods of vehicles, the average and median values of vehicle use were investigated for the group as a whole. During this analysis it was also investigated, with the hope of further understanding movement patterns, where individuals spent their time during the day; whether it be at home, travelling, or at other activities/locations. Overall, it was found that individuals spent around 4-5% of their time in their vehicles each day. These percentages were true for both the average and the median datasets. The time spent in the vehicle did not shift during the four-week study period and therefore no statistically significant trends were found to be present; however, there were shifts present relating to the amount of time that individuals spent either at home or at other locations. As such, it was concluded that time spent in the vehicle was relatively inelastic, whereas time spent at other locations appeared to be rather flexible. An estimated 4-5% of daily allowance equates to 58 to 72 minutes of time spent utilising private vehicles. In total, the average participant was found to spend 66 minutes utilising their private vehicle per day. This finding is in line with a similar statement made by Steer Davies Gleave (2017) that, on average, a car is utilised around 5% (72 minutes) of the day. A possible reason for why the average utilisation within this research study was found to be slightly below the amount stated by Steer Davies Gleave (2017) may be due to the fact that the metropolitan areas of Stellenbosch are not as highly congested as other large cities, and as such the travel times experienced by individuals in the city limits tend to be slightly faster than those experienced within large congested metropolitan areas. When investigating when individuals utilised their vehicles, two trends were found within the median and average values, although once again these trends lacked statistical significance to support them. The trends illustrated that as time progressed, individuals began their day by slightly postponing their first trip while ensuring that their last trip of the day would occur earlier. Thus, it could be assumed that these indicators illustrate the participants' attempt to alter their travel behaviour in a way so that the participants could commute at times when less congestion was present.

The final travel behaviour variable measured in the research exercise was the number of trips that participants took per day. Once again, the average and median values regarding the number of trips

undertaken were investigated. When attempting to deduce findings from the daily number of trips undertaken during the study, it was found that a similar trend for both the average and median values was present; this trend illustrated that the number of trips decreased as time progressed. Unfortunately, no statistical significance could be found when attempting a regression analysis; however, this could potentially be explained by the low number of participants who took part in the study, or perhaps due to there being a lack of impact from the intervention technique itself.

When investigating the various demographics of the participants in order to attempt to conclude any relevant findings, it was uncovered that, on average, men drove fewer kilometres while simultaneously undertaking fewer trips but spent more time utilising their vehicles than women. A possible reason for the difference in behaviour between men and women could be due to the reason that women in South Africa generally tend to be the caretakers of the household, in which case their duties may include childcare as well as housekeeping duties. If this assumption is in fact found to be the case, it could potentially explain the discrepancy between the travel behaviours of men and women. Women would therefore leave home earlier and return home later in order to drop children off at school, in addition to doing grocery shopping, and thus need to undertake more trips while simultaneously driving farther distances than men. Men, on the other hand, would spend more time in their vehicle due to driving during the most congested times of the day, which women avoid due to their additional duties, which would explain why they appear to be more efficient with their time.

The participants who identified themselves as registered vehicle owners also appeared to drive longer distances and spent more time in their vehicles; however, they achieved this by taking fewer trips than individuals who were not registered vehicle owners. Perhaps, in this case, registered vehicle owners owned their vehicles out of necessity required by driving long distances and thus purchased the vehicles, whereas non-registered vehicle owners would use the vehicles at their disposal more liberally. Alternatively, as pointed out by Cullinane and Cullinane (2003), it could be possible that once people acquire a private vehicle, their perception leads them to believe that the vehicle must become a necessary part of their lifestyle.

On a final note, regarding the findings associated with behavioural patterns, it was observed that when converting the median values of kilometres driven into the monetary costs and environmental emissions experienced throughout the study, Figure 5.1 illustrated medians for monetary expenditure, and Figure 5.2 illustrated environmental emissions, with gradients appearing to be more severe in the case of monetary expenditure than for environmental emissions. A potential reason for the greater gradient in trend is that participants may have been more motivated to decrease their monetary expenditure than reducing their environmental impact. Thus, even though a decrease in kilometres was experienced for all participants when investigating median values, the individuals who decreased

their total kilometres driven had a greater impact on the monetary spending of the group than the carbon emissions created by the group.

To conclude the findings of this study, it should be stated that, as mentioned in Chapter 2, transport and travel behaviours in general are habitual in nature and are therefore rather challenging to alter in the short term (Thøgersen, 2006). As such, the results and findings of this research study failed to show any statistically significant trends throughout the data analysis, although general trends within the various average and median values were found. This is in line with and corroborates the findings of various other studies that were identified and discussed in Chapter 2, where only relatively minor alterations in travel behavioural trends were observed due to the introduction of educational TDM interventions. It can therefore be assumed that even though educational measures are more cost effective than other types of TDM techniques, it is possible that they lack the impact required to be implemented in a large-scale, real-world scenario. This is potentially a reason why they are not as prevalent as other methods when attempting to curb the overall demand associated with transportation.

One indicator that, in the author's opinion, holds great promise regarding future TDM techniques such as this one, was the shift in estimated cost across all participants. It was found that, of the 19 participants who completed both questionnaire sets, the cost estimations per kilometre increased by an average of 52 cents per kilometre, which translated into an increase of around 27% after being exposed to the informational invoices. In the opinion of the author, this indicator illustrates internalisation regarding the cost information shared with participants. If this internalisation is maintained for an extended period of time, it will potentially manifest into an alteration in travel behaviour. This may either occur by a shift towards more affordable transport modes, or alternatively changing where individuals choose to live and work (with the emphasis on that they would choose to live in locations that would allow for reduced private vehicle usage).

6.2 RECOMMENDATIONS

For future studies it is recommended that a similar process to what was utilised in this research exercise be adapted for a larger sample size, as well as for a longer period of time, alternatively a longitudinal study could be suggested which would aim to track the same participants which were involved in this research exercise to better understand if alterations in travel behaviour occurred over a longer period of time. Due to habits requiring longer periods of time to be broken or altered, it is recommended that a future study take place over multiple months, if not years, in order to truly assess whether travel behaviour was altered after presenting research participants with various cost and environmental information. By having a longer period in which to monitor participants, researchers

would also be able to negate any seasonality that could influence participants' travel behaviour due to changes in climate or other external influences. Due to the relatively small scale of this research study, it is recommended that future studies attempt to monitor the travel behaviour of a minimum of 200 individuals in order to attain statistically significant findings relating to their overall alterations of travel behaviour. In order to monitor a larger number of individuals, it is also suggested that the method of tracking to be used in future research be via GPS devices that utilise the GSM network to relay data, as these device types allow for data collection with minimal intrusion for participants and were found to be accurate with regard to the actual distances travelled (1% margin of error).

Finally, it is recommended that the various types of information relayed to the participants be reviewed and that the detail thereof be more comprehensive in order to assist the participants in not only viewing their costs and environmental impacts associated with private vehicle transportation, but also in developing a better overall understanding of how these costs and impacts are incurred and how they could be reduced overall.

REFERENCE LIST

Adiv, A. 1982. Commuter's Versus Analyst's Perception of Automobile Travel Cost. *Transportation Research Record*. (890):18–24.

Albert, G. & Mahalel, D. 2006. Congestion tolls and parking fees: A comparison of the potential effect on travel behavior. *Transport Policy*. 13(6):496–502.

Arbor Environmental Alliance. 2008. *Carbon & Tree Facts*. [Online], Available: http://www.arborenvironmentalalliance.com/carbon-tree-facts.asp [2016, July 30].

Bamberg, S., Fujii, S., Friman, M. & Gärling, T. 2011. Behaviour theory and soft transport policy measures. *Transport Policy*. 18(1):228–235.

Beirão, G. & Sarsfield Cabral, J.A. 2007. Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy*. 14:478–489.

Borg, W. 1982. Subjective Perception of Car Costs (Abridgment). *Transport Research Record*. (858):43–48.

Cairns, S., Newson, C. & Davis, A. 2010. Understanding successful workplace travel initiatives in the UK. *Transportation Research Part A: Policy and Practice*. 44(7):473–494.

Carbon Neutral Pty Ltd. 2015. *Plant-A-Tree*. [Online], Available: http://carbonneutral.com.au/plant-a-tree/ [2016, September 15].

Cotterill, J. 2018. *South Africa: How Cape Town beat the drought*. [Online], Available: https://www.ft.com/content/b9bac89a-4a49-11e8-8ee8-cae73aab7ccb [2018, May 21].

Cullinane, S. 1992. Attitudes towards the car in the U.K.: Some implications for policies on congestion and the environment. *Transportation Research Part A: Policy and Practice*. 26(4):291–301.

Cullinane, S. & Cullinane, K. 2003. Car dependence in a public transport dominated city: evidence from Hong Kong. *Transportation Research Part D: Transport and Environment*. 8(2):129–138.

D'Acierno, L., Gallo, M. & Montella, B. 2006. Optimisation models for the urban parking pricing problem. *Transport Policy*. 13(1):34–48.

Department of Transport: Republic of South Africa. 2015. *National Land Transport Strategic Framework Final Draft - March 2015*.

Duncan, M.J., Badland, H.M. & Mummery, W.K. 2009. Applying GPS to enhance understanding of transport-related physical activity. *Journal of Science and Medicine in Sport*. 12(5):549–556.

Ellaway, A., Macintyre, S., Hiscock, R. & Kearns, A. 2003. In the driving seat: psychosocial benefits from private motor vehicle transport compared to public transport. *Transportation Research Part F: Traffic Psychology and Behaviour*. 6(3):217–231.

Froehlich, J., Dillahunt, T., Klasnja, P., Mankoff, J., Consolvo, S., Harrison, B. & Landay, J.A. 2009. UbiGreen: Investigating a mobile tool for tracking and supporting green transportation habits. In *Proceedings of the 27th International Conference on Human Factors in Computing Systems – CHI 09*. [Online]. Available: https://www.cs.umd.edu/~jonf/publications/Froehlich_UbiGreen-InvestigatingAMobileToolForTrackingAndSupportingGreenTransportationHabits_CHI2009.pdf [2017, September 15].

Gardner, B. & Abraham, C. 2007. What drives car use? A grounded theory analysis of commuters' reasons for driving. *Transportation Research Part F: Traffic Psychology and Behaviour*. 10(3):187–200.

Gärling, T. & Schuitema, G. 2007. Travel Demand Management Targeting Reduced Private Car Use: Effectiveness, Public Acceptability and Political Feasibility. *Journal of Social Issues*. 63(1):139–153.

Gärling, T., Eek, D., Loukopoulos, P., Fujii, S., Johansson-Stenman, O., Kitamura, R., Pendyala, R. & Vilhelmson, B. 2002. A conceptual analysis of the impact of travel demand management on private car use. *Transport Policy*. 9(1):59–70.

Government of South Africa. 2015. *National Transport Policy White Paper*. [Online], Available: http://www.gov.za/documents/national-transport-policy-white-paper [2016, February 16].

Gwilliam, K. 2003. Urban transport in developing countries. *Transport Reviews*. 23(2):197–216.

Hensher, D.A. 2006. The imbalance between car and public transport use in urban Australia : why does it exist ? *Transport Policy*. 5(1998):193–204.

Janicki, S.V. 2015. *Time for a Reality Check: Assessing Perceived versus Actual Vehicle Operating Costs*. Department of Logistics. Stellenbosch: Stellenbosch University.

Jariyasunant, J., Abou-Zeid Maya, Carrel, A., Ekambaram, V., Gaker, D., Sengupta, R. & Walker, J. 2015. Quantified Traveler: Travel Feedback Meets the Cloud to Change Behavior. *Journal of Intelligent Transportation Systems*. 19(November 2015):109–124.

Jensen, M. 1999. Passion and heart in transport - a sociological analysis on transport behaviour. *Transport Policy*. 6(1):19–33.

Johansson-Stenman, O. & Martinsson, P. 2006. Honestly, why are you driving a BMW? *Journal of Economic Behavior & Organization*. 60(2):129–146.

Kelly, J.A. & Clinch, P.J. 2006. Influence of varied parking tariffs on parking occupancy levels by trip purpose. *Transport Policy*. 13(6):487–495.

Kitamura, R., Yoshii, T. & Yamamoto, T. 2009. *The Expanding Sphere of Travel Behaviour Research - Selected Papers from the 11th International Conference on travel Behaviour Research*.

LeasePlan South Africa. 2016. *Vehicle running costs - The AA Rates*. [Online], Available: https://web.archive.org/web/20160406123804/http://www.diskdrive.co.za:80/leaseplan/aa_rates.html [2016, February 10].

Mahmood, M., Bashar, M.A. & Akhter, S. 2009. Traffic management system and travel demand management (tdm) strategies: suggestions for urban cities in Bangladesh. *Asian Journal of Management and Humanity Sciences*, *4*(2-3), pp.161-178.

Malecki, A.M. 1978. Perceived and actual costs of operating cars. *Transportation*. 7:403–415.

Mokonyama, M. & Venter, C. 2007. Forecasting household car ownership in South Africa : alternative models. *Journal of the South African Institution of Civil Engineering*. 49(3):2–10.

New Zealand Transport Agency. 2016. *CO2 Emission Ratings*. [Online], Available: http://rightcar.govt.nz/co2-ratings.html [2016, July 10].

Nordlund, A.M. & Garvill, J. 2003. Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. *Journal of Environmental Psychology*. 23(4):339–347.

Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Wardman, M., Shires, J. & White, P. 2006. The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transport Policy*. 13(4):295–306.

Pienaar, W.J. 1996. Economic Evaluation of Passenger Transport Terminals and Transport Facilities. *Australasian Transport Research Forum*. 20(2).

Pienaar, W.J. 1997. Modelling generalised transit commuter costs for use in urban transport planning. *Transactions on the Built Environment*. 30:1–8.

Rose, G. & Ampt, E. 2001. Travel blending: An Australian travel awareness initiative. *Transportation Research Part D: Transport and Environment*. 6(2):95–110.

Rothengatter, W. 1994. Do external benefits compensate for external costs of transport? *Transportation Research Part A*. 28(4):321–328.

Schlag, B. & Teubel, U. 1997. Public acceptability of transport pricing. *IATSS Research*. 21(2):134–142.

Sohail, M., Maunder, D.A.C. & Cavill, S. 2006. Effective regulation for sustainable public transport in developing countries. *Transport Policy*. 13(3):177–190.

Statistics South Africa (Stats SA). 2013. *What Do South Africans Spend Their Money on*. [Online]. Available: http://www.statssa.gov.za/?p=944 [2016, May 08].

Statistics South Africa (Stats SA). 2014. *National Household Travel Survey: February to March 2013*. South Africa: Stats SA.

Steer Davies Gleave. 2017. *Parking demand in the autonomous vehicles era*. [Online], Available: http://www.steerdaviesgleave.com/news-and-insights/Parking-demand-in-the-autonomous-vehicles-era [2017, August 25].

Steg, L. 2005. Car use: Lust and must. Instrumental, symbolic and affective motives for car use. *Transportation Research Part A: Policy and Practice*. 39(S2–3):147–162.

Stopher, P.R. 2004. Reducing road congestion: a reality check. *Transport Policy*. 11(2):117–131.

Stopher, P., Clifford, E., Swann, N. & Zhang, Y. 2009. Evaluating voluntary travel behaviour change: Suggested guidelines and case studies. *Transport Policy*. 16(6):315–324.

Stradling, S., Meadows, M. & Beatty, S. 2000. Helping drivers out of their cars: Integrating transport policy and social psychology for sustainable change. *Transport Policy*. 7(3):207–215.

Tertoolen, G., van Kreveld, D. & Verstraten, B. 1998. Psychological resistance against attempts to reduce private car use. *Transportation Research Part A: Policy and Practice*. 32(3):171–181.

Thambiran, T. & Diab, R.D. 2011. Air pollution and climate change co-benefit opportunities in the road transportation sector in Durban, South Africa. *Atmospheric Environment*. 45(16):2683–2689.

The Carbon Report's Blog. 2016. *The Proposed South African Carbon Tax*. [Online], Available: http://www.thecarbonreport.co.za/the-proposed-south-african-carbon-tax/ [2016, August 12].

Thøgersen, J. 2006. Understanding repetitive travel mode choices in a stable context: A panel study approach. *Transportation Research Part A: Policy and Practice*. 40(8):621–638.

Venter, M.C., Hitge, G., Krygsman, S.C. & Thiart, J. 2018. Changing the way South Africa think about parking provision at tertiary institutions. *World Academy of Science, Engineering and Technology International Journal of Transport and Vehicle Engineering*. 12(7):850-856.

Walters, J. 2008. Overview of public transport policy developments in South Africa. *Research in Transportation Economics*. 22(1):98–108.

Wikipedia. 2017. *Passenger Load Factor*. [Online], Available: https://en.wikipedia.org/wiki/Passenger_load_factor [2018, February 01].

ADDENDA

ADDENDUM A: INVITATION LETTER

UNIVERSITEIT STELLENBOSCH UNIVERSITY

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The Informed Traveller: A Proposed Travel Demand Management Intervention Technique

Stellenbosch University, in conjunction with the Municipality of Stellenbosch, is conducting a research study that will improve our understanding of how individuals perceive the travel and environmental costs of their transport choice. We aim to investigate the viability of utilising personal travel pattern feedback techniques to reduce private vehicle usage.

The study consists of 2 surveys as well as a vehicle tracking exercise. The initial survey, which should take 5 minutes to complete, will collect general information about your private vehicle and general travel habits. The vehicle tracking will take place over a four-week period. During the first week, your normal travel patterns will be established. Following this, the researchers will provide you with feedback every Monday. The feedback will consist of the financial cost and environmental footprint relating to your travels during the past week along with possible options to reduce these two elements. The subsequent weeks of travel will assist in determining whether you were able to reduce either of these two elements using the information supplied. The second survey, will take place after the vehicle tracking period has been completed and collect information regarding the possible changes in perception that may have occurred due to the feedback information delivered via e-mail.

All vehicle tracking information will be kept confidential. Various measures will be taken to help ensure that personal identifiers are not revealed during the analysis and write up of findings.

There is no compensation for participating in this study. In addition to receiving information regarding your own travel behaviour, your participation will be a valuable addition to our research.

If you are willing to participate, please register at:
https://sunsurveys.sun.ac.za/Travel-Cost-Awareness-Signup.aspx

A member of our project team will contact the respondents. If you have any further questions, please do not hesitate to contact us.

Thank you for your interest. We look forward to your participation in this important research project.

Kind regards,
Steven Janicki
0835018712
sjan@sun.ac.za

ADDENDUM B: SIGN-UP FORM

The Informed Traveller Research Participant Form

Contact Information:

Please fill out the relevant information to take part in the Stellenbosch University research study.
Please note that participation for the research study will undergo a selection process.

***Do you use your private vehicle to travel to work?**

- Yes
- No

***Was your vehicle manufactured after 1996?**

- Yes
- No

***Name and Surname:**

***Contact Number:**

***Email Address:**

Finish

ADDENDUM C: FIRST QUESTIONNAIRE

Page 1

The Informed Traveller:
A Proposed Travel Demand Management Intervention Technique

Survey 1

Good day and thank you taking the time to complete this survey.

This survey forms part of a research study which aims to analyse your transport and activity patterns using a combination of questionnaires and GPS devices for vehicle location tracking over a two week period. Using this combination of data collection instruments, the research will endeavour to measure elements of personal travel. These elements include the personal costs of travel, travel time and environmental costs (carbon emissions, in particular).

This is all done to investigate the potential viability of monetary and environmental feedback techniques in the hopes of reducing private vehicle usage. The feedback will be delivered by means of an invoice style document and will be e-mailed to participants between the first and second week of vehicle tracking. Additional objectives include assisting in increasing the overall understanding of how travel behaviour is perceived, experienced and influenced.

If you volunteer to participate in this study, you will:

1. Accept the terms and conditions in this consent form;
2. Participate in two data collection questionaires (this survey and one more);
3. Provide a valid e-mail address that you will be able to access over weekends in order to receive the feedback document;
4. Agree to have your private vehicle tracked by means of GPS device for a period of 2 weeks.

Disclaimer:

This study has been approved by the Humanities Research Ethics Committee (HREC) at Stellenbosch University and will be conducted according to accepted and applicable national and international ethical guidelines and principles.

All data collected through this survey will be used in order to conduct a Masters Research Study in conjunction with Stellenbosch University named:
The Informed Traveller: A Proposed Travel Demand Management Intervention Technique

Any information that is obtained in connection with this study that can be used to identify individuals, will remain confidential and will be disclosed only with your permission, or as required by law. Confidentiality will be maintained by the fact that no names will be used in any report. No information will be released to any other party for any reason. The researchers plan to publish results of the study, but confidentiality will be maintained in publication by anonymising all data gathered – no details regarding individual participants that can be traced back to an individual will be disclosed.

Your response to the survey is completely voluntary, however please note that if you wish to continue with the study (i.t.o. tracking etc.) the completion of the survey will be necessary.
If you do not wish to continue taking part with the survey/study you may cancel your participation at any point, and will not be penalized for doing so.
You will receive no payment for your participation in this study.

If you have any additional questions please feel free to contact the researcher of this study, details are as follows:
Mr. Steven Janicki
c: 0835018712
e: sjan@sun.ac.za

DECLARATION BY PARTICIPANT

I hereby consent voluntarily to participate in this study. I declare that:

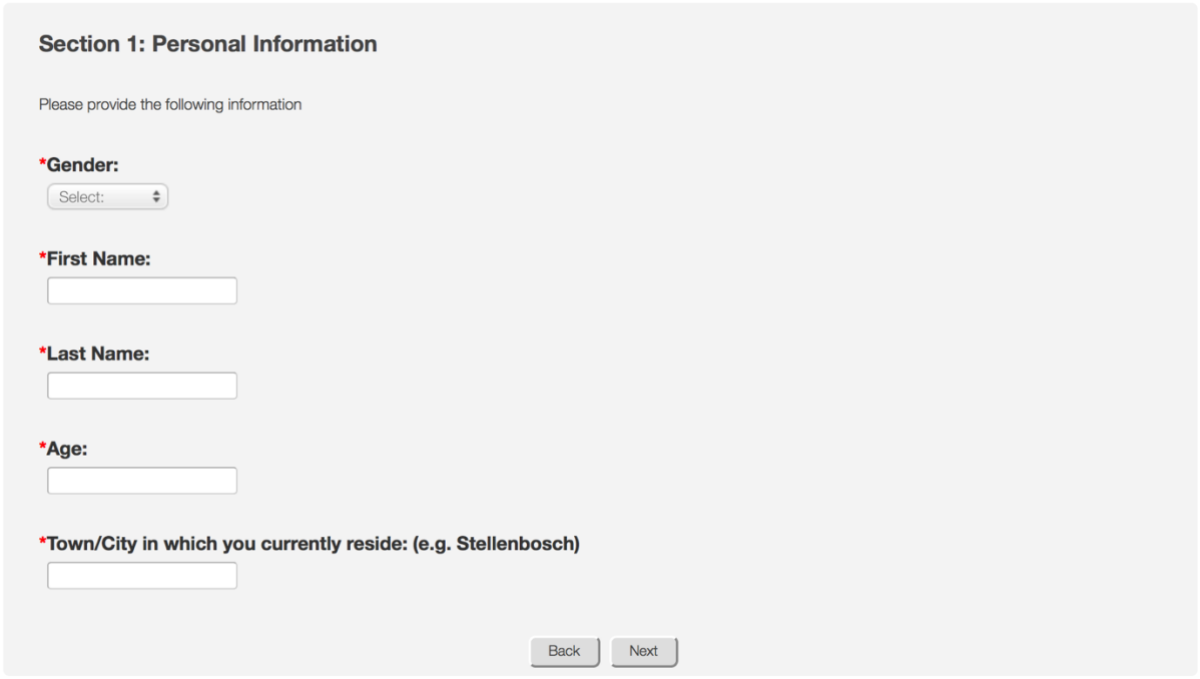
1. I have read the above information and it is written in a language in which I am fluent and comfortable.
2. I have had a chance to ask questions and all my questions have been adequately answered.
3. I understand that taking part in this study is voluntary and I have not been pressurised to take part.
4. I may choose to leave the study at any time and will not be penalised or prejudiced in any way if I do.
5. I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.
6. All issues related to privacy and the confidentiality and use of the information I provide have been explained to my satisfaction.

***If you agree with the terms and conditions mentioned above please select Agree to continue, if not please select Disagree.**

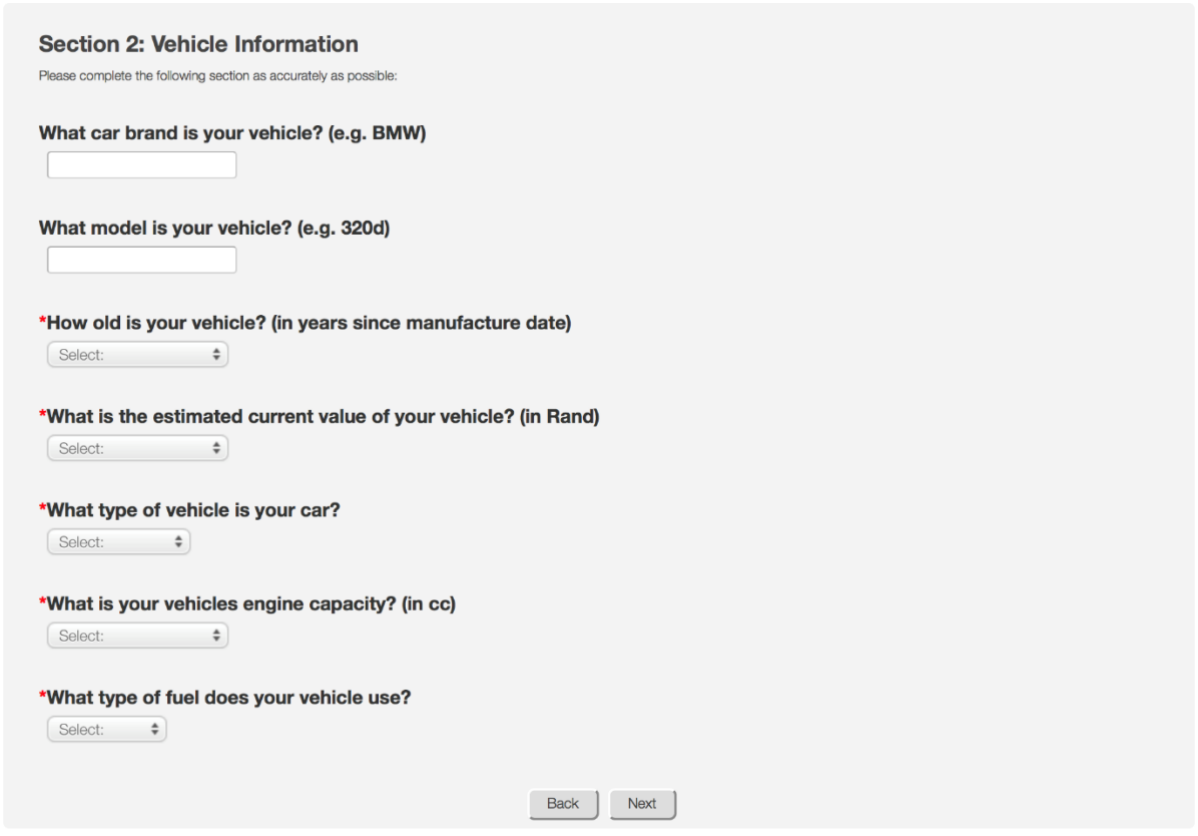
- ○ Agree
- ○ Disagree

Next

Page 2



Page 3



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Section 3: Travel Behaviour

Please complete the following section:

*Are you the registered owner of the vehicle described in Section 2?

Select:

*On Average: How many days per week do you utilise your private vehicle to commute to work?

Select:

*Do you commute to work alone or with at least 1 other person? (e.g. car-pool)

Select:

*On Average: How many Kilometres do you drive PER WEEK? (Monday to Sunday)

*On Average: How much would you estimate your vehicle to cost you PER WEEK? (Monday to Sunday)

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Section 4: Transport Sacrifices/Disutilities

Please ensure you read and understand the following before continuing:

The transport modes that we utilise are associated with sacrifices.
These sacrifices include: **Money**, **Time** and **Other Aspects** (e.g. Pollution, Discomfort and Inconvenience).

These sacrifices have a negative impact on our lives.

*Seeing that transport has accompanying sacrifices associated with it. On a scale of 1 to 10 (1 being not at all, and 10 being very high), please indicate how strongly you believe these personal transport sacrifices negatively impact you and your life.

	Not at all				Average					Very High
	1	2	3	4	5	6	7	8	9	10
Monetary Cost (Money)	○	○	○	○	○	○	○	○	○	○
Travel Time	○	○	○	○	○	○	○	○	○	○
Other Aspects	○	○	○	○	○	○	○	○	○	○

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Section 5: Questions About Private Transport

What are the main reasons for using private transport to go to work? More than one option can be ticked. Please also rank all the options ticked, with 5 indicating your most important reason and 1 indicating the least important reason.

	1	2	3	4	5
Private Transport is essential to perform my work.	○	○	○	○	○
Private Transport is safer.	○	○	○	○	○
There is a lack of suitable alternatives.	○	○	○	○	○
Private Transport is the most convenient option.	○	○	○	○	○
Private Transports the quickest option.	○	○	○	○	○
Private Transport is the cheapest option.	○	○	○	○	○

Which of the following reasons would encourage you to use your private vehicle less? More than one option can be ticked. Please also rank all the options ticked, with 5 indicating your most important reason and 1 indicating the least important reason.

	1	2	3	4	5
Reduction of my carbon footprint and my impact on the environment. - (Other Aspect)	○	○	○	○	○
Reliable, affordable and safe alternatives (e.g. car pooling, public transport). - (Other Aspect)	○	○	○	○	○
Avoiding peak hour congestion. - (Time Aspect)	○	○	○	○	○
A reduction of my monthly costs. - (Monetary Aspect)	○	○	○	○	○

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Section 6: Contact Information

Thank you for completing the survey.

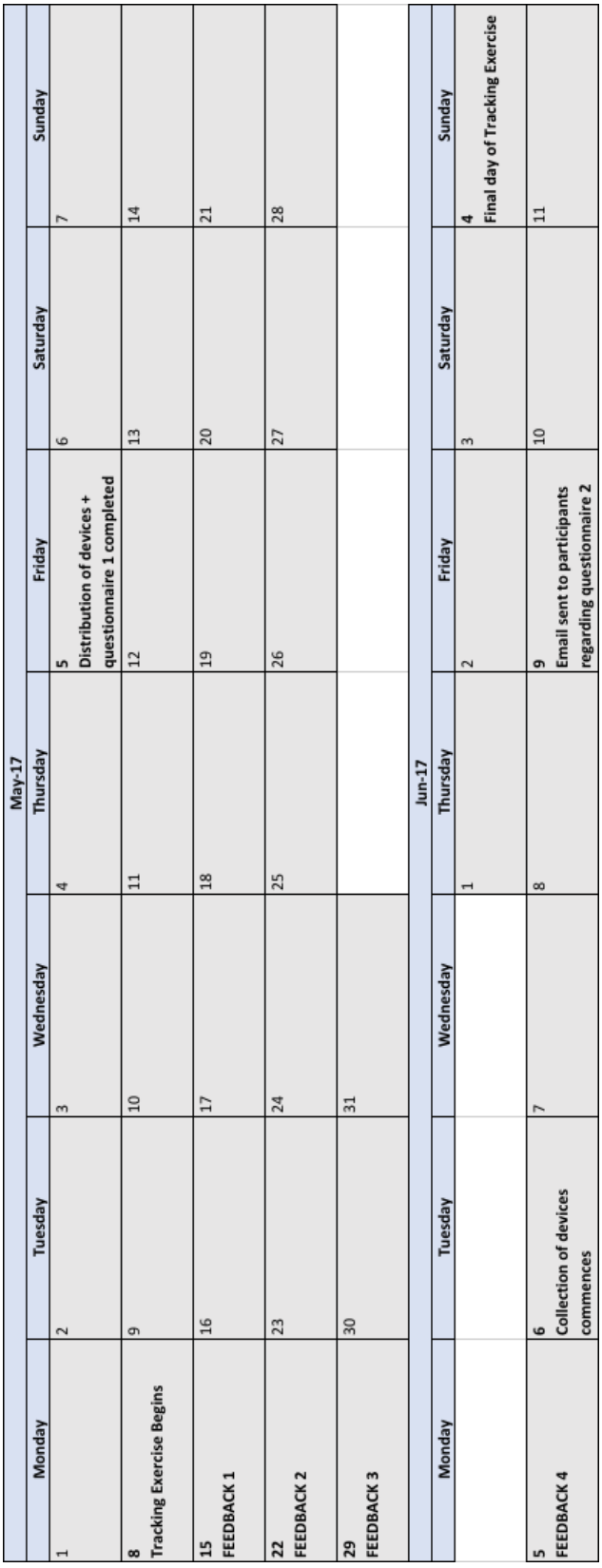
Please enter your contact details below to ensure you receive your Travel Feedback Information.

***Please enter your contact number:**

***Please enter your email address:**

Back Finish

ADDENDUM D: RESEARCH EXERCISE TIMELINE



May-17						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	2	3	4	5 Distribution of devices + questionnaire 1 completed	6	7
8 Tracking Exercise Begins	9	10	11	12	13	14
15 FEEDBACK 1	16	17	18	19	20	21
22 FEEDBACK 2	23	24	25	26	27	28
29 FEEDBACK 3	30	31				

Jun-17						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
			1	2	3	4 Final day of Tracking Exercise
5 FEEDBACK 4	6 Collection of devices commences	7	8	9 Email sent to participants regarding questionnaire 2	10	11

ADDENDUM E: MONETARY AND ENVIRONMENTAL INVOICES

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INVOICE
*
FAKTUUR

Datum Date	Faktuur nom Invoice num
01/01/2017	M319136
Bladsy Page	1 van / of 2

KLIËNT/GPS NOMMER: CLIENT/GPS NUMBER:	KLIËNT BESONDERHEDE: CLIENT DETAILS:	KLIËNT KONTAKBESONDERHEDE: CLIENT CONTACT DETAILS:	NAVORSER BESONDERHEDE: RESEARCHER DETAILS:
	Participant Name	Contact Number	Mr. Steven Janicki
20	Location of Living	Contact Email	083 501 8712
GPS - 1	Vehicle Make and Model		sjan@sun.ac.za

FAKTUUR TIPE:
INVOICE TYPE:

MONETÊRE KOSTE-INLIGTIG
MONETARY COST INFORMATION

Kilometers afgelê Kilometers driven	Kostekomponent Cost component	Koste per kilometer (Rand) Cost per kilometer (Rand)	Bedrag Amount
154.2	**FIXED COST:**	**1.18**	**181.96**
Kilometers driven	**RUNNING COSTS:**		
over past week	FUEL + LUBRICATION	0.67	**103.30**
	TYRES	0.24	**36.67**
	MAINTENANCE	0.27	**42.20**
*Let wel koste is vir jou reis gedrag deur die afgelope week bereken. Note costs are calculated on your travel behavior over the past week.		**TOTAAL VIR DIE WEEK: TOTAL FOR THE WEEK:**	**R 364.13**

*Berekeninge en data wat ingesamel is, mag dalk nie 100% akkuraat wees nie. / Calculations and collected data may not be 100% accurate.

ADDITIONAL INFORMATION:			
	Total number of **Vehicle Trips** taken this week:	**30 trips**	
	Your **Total Time** Spent while using your vehicle was:	**6h 36m**	THIS PAST WEEK
	Your Private Vehcile is Estimated to Cost you:	**R 18,986.67**	PER YEAR
	If you reduce your vehicle usage by **15%** you could save up to:	**R 2,848.00**	PER YEAR
If you choose not to use your vehicle for an average of **2 days per week** you could save:		**R 5,424.76**	PER YEAR

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INVOICE
*
FAKTUUR

Datum Date	Faktuur nom Invoice num
01/01/2017	M319136e
Bladsy Page	2 van / of 2

KLIËNT/GPS NOMMER: CLIENT/GPS NUMBER:	KLIËNT BESONDERHEDE: CLIENT DETAILS:	KLIËNT KONTAKBESONDERHEDE: CLIENT CONTACT DETAILS:	NAVORSER BESONDERHEDE: RESEARCHER DETAILS:
	Participant Name	Contact Number	Mr. Steven Janicki
20	Location of Living	Contact Email	083 501 8712
GPS - 1	Vehicle Make and Model		sjan@sun.ac.za

FAKTUUR TIPE:
INVOICE TYPE:

OMGEWINGSKOSTE INLIGTING
ENVIRONMENTAL INFORMATION

Kilometers afgelê Kilometers driven	Kostekomponent Cost component	Gram CO2 per kilometer Grams of CO2 per kilometer	Hoeveelhied (kg) Amount (kg)
154.2	**CO2 EMISSIONS**	**158.64**	
Kilometers driven			
over past week	CO2 EMISSIONS FOR THE WEEK		**24.46**
	ESTIMATED CO2 EMISSIONS FOR THE YEAR		**1275.57**
	TREES TO BE PLANTED TO RECOVER YEARLY CO2 EMISSIONS (ONE TREE ABSORBS APROX. 12KG OF CO2 PER YEAR)		**106.30 Trees**
*Let wel die koste is bereken as R40 per boom. Note the cost per tree is calculated as R40.		**TOTAAL VIR DIE JAAR: TOTAL FOR THE YEAR:**	**R 4,251.90**

*Jaarlikse koste is bereken deur die afstand gereis oor die afgelope week. / Yearly cost is caluclated on distance travelled over the past week.

ADDENDUM F: SECOND QUESTIONNAIRE

Welcome to Survey 2 of the The Informed Traveller Research

Please complete this short survey.

***What is your First Name?**

***What is your Surname?**

***On Average: How many Kilometres do you drive PER WEEK ? (Monday to Sunday in Kilometres)**

***On Average: How much would you estimate your vehicle to cost you PER WEEK ? (Monday to Sunday in Rands)**

***Seeing that transport has accompanying sacrifices associated with it. On a scale of 1 to 10 (1 being not at all, and 10 being very high). Please indicate how strongly you believe these personal transport sacrifices negatively impact you and your life.**

	1	2	3	4	5	6	7	8	9	10
Monetary Cost (Money)	○	○	○	○	○	○	○	○	○	○
Travel Time	○	○	○	○	○	○	○	○	○	○
Other Aspects	○	○	○	○	○	○	○	○	○	○

***On a scale of 1 to 5, please indicated your preference relating to the following statement:**

Due to the Intervention Technique(Invoice), there is now a LESSER, EQUAL or GREATER level of likelihood regarding my use of the following transportation modes.

1 = Less Likely

3 = Same as before research study

5 = More Likely

	Less Likely		Same Likelihood		More Likely
	1	2	3	4	5
Non-Motorized Transport (eg. Bicycle, Walking)	○	○	○	○	○
Public Transportation	○	○	○	○	○
Car-Pool	○	○	○	○	○

***Did you find the information provided (Monetary/Environmental Invoices) during the study as beneficial or informative?**

- ○ Yes
- ○ No

***Would you prefer receiving information such as your Monetary/Environmental Invoice on a WEEKLY or MONTHLY basis?**

- ○ Weekly
- ○ Monthly
- ○ N/A

***Are you willing to partake in a different study which would assess your Road User Cost for the funding of road infrastructure?**

- ○ Yes
- ○ No

Finish

ADDENDUM G: SUMMARY TABLE OF AA RATES

FIXED COSTS

AVERAGED FIXED COST (C/KM)

PURCHASE PRICE (VAT INCL.)	ANNUAL DISTANCE TRAVELLED - KM (FIXED COST INDICATED IN CENTS PER KILOMETRE)							
	10000	15000	20000	25000	30000	35000	40000	45000
up to 30,000	92	62	46	37	31	28	24	22
30,001 - 50,000	155	103	78	63	53	46	41	37
50,001 - 75,000	230	153	115	93	78	69	61	55
75,001 - 100,000	308	206	155	125	105	92	81	74
100,001 - 125,000	373	249	187	151	127	111	99	89
125,001 - 150,000	445	297	224	180	152	133	118	107
150,001 - 175,000	506	338	254	205	172	151	134	121
175,001 - 200,000	581	388	292	236	198	174	154	139
200,001 - 250,000	730	487	366	296	249	218	193	175
250,001 - 300,000	848	566	426	344	289	254	225	204
300,001 - 350,000	995	664	500	404	339	298	264	239
350,001 - 400,000	1143	763	574	464	390	342	303	275
> 400,001	1294	864	650	525	441	387	343	311

PETROL LCV's
AA RATES OF VEHICLE OPERATING COSTS
AVERAGED RUNNING COST (C/KM)

All Costs include VAT

ENGINE CAPACITY (cc)	PETROL MAINTENANCE		PETROL
	Service & Repairs	Tyres	Factor
<2000	12.52	9.57	11.01
2001 - 2500	15.45	15.32	13.65
2501 - 3000	17.18	17.00	13.94
3001 - 4000	24.60	19.76	15.18
>4001	31.04	19.76	16.10
	A	B	C

Running Cost Calculation (ckm) = A + B + (C*Petrol Price in R/Litre)

PETROL CARS
AA RATES OF VEHICLE OPERATING COSTS
AVERAGED RUNNING COST (C/KM)

All Costs include VAT

ENGINE CAPACITY (cc)	PETROL MAINTENANCE		PETROL
	Service & Repairs	Tyres	Factor
<1300	13.90	6.71	8.18
1301 - 1500	12.63	8.90	8.61
1501 - 1800	14.67	12.14	10.41
1801 - 2000	17.01	19.53	11.01
2001 - 2500	18.36	21.94	12.18
2501 - 3000	21.16	27.22	12.73
3001 - 4000	32.15	31.18	14.54
>4001	36.04	42.30	14.94
	A	B	C

' Running Cost Calculation (ckm) = A + B + (C*Petrol Price in R/Litre)

DIESEL LCV's
AA RATES OF VEHICLE OPERATING COSTS
AVERAGED RUNNING COST (C/KM)

All Costs include VAT

ENGINE CAPACITY (cc)	DIESEL MAINTENANCE		DIESEL
	Service & Repairs	Tyres	Factor
<2000	15.31	9.57	6.84
2001 - 2500	21.56	15.32	11.46
2501 - 3000	17.84	17.00	11.69
>3001	31.04	19.76	14.90
	A	B	C

Running Cost Calculation (ckm) = A + B + (C*Diesel Price in R/Litre)

DIESEL CARS
AA RATES OF VEHICLE OPERATING COSTS
AVERAGED RUNNING COST (C/KM)

All Costs include VAT

ENGINE CAPACITY (cc)	DIESEL MAINTENANCE		DIESEL
	Service & Repairs	Tyres	Factor
< 2000	16.02	19.53	6.88
2001 - 2500	29.02	21.94	10.47
2501 - 3000	31.57	27.22	10.78
3001 - 4000	30.29	31.18	11.59
>4001	31.04	42.30	13.37
	A	B	C

ADDENDUM H: ETHICAL CLEARANCE APPROVAL LETTER

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Approval Notice
New Application

24-Apr-2017
Janicki, Steven SV

Proposal #: SU-HSD-004470
Title: The Informed Traveller: A Proposed Travel Demand Management Intervention Technique

Dear Mr Steven Janicki,

Your **New Application** received on **29-Mar-2017**, was reviewed
Please note the following information about your approved research proposal:

Proposal Approval Period: **24-Apr-2017 -23-Apr-2020**

Please take note of the general Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

Please remember to use your **proposal number** (**SU-HSD-004470**) on any documents or correspondence with the REC concerning your research proposal.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Also note that a progress report should be submitted to the Committee before the approval period has expired if a continuation is required. The Committee will then consider the continuation of the project for a further year (if necessary).

This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki and the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health). Annually a number of projects may be selected randomly for an external audit.

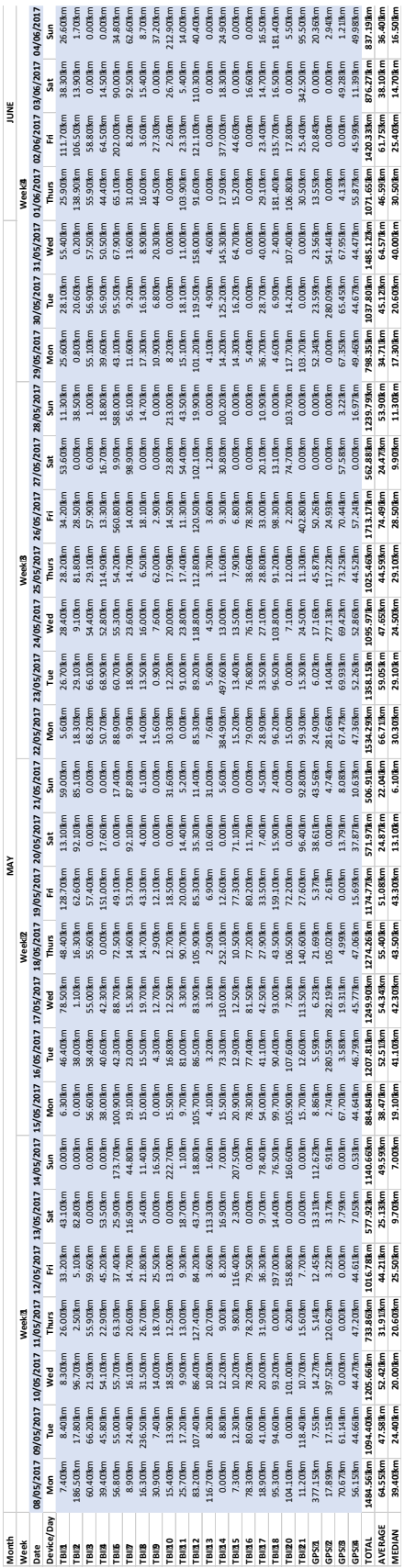
National Health Research Ethics Committee (NHREC) registration number REC-050411-032.

We wish you the best as you conduct your research.

If you have any questions or need further help, please contact the REC office at 218089183.

Included Documents:

ADDENDUM I: DAILY KILOMETRES TRAVELLED BY PARTICIPANTS DURING THE RESEARCH PERIOD



Month																																
Week					Week1						Week2						Week3						Week4									
Date	08/05/2017	09/05/2017	10/05/2017	11/05/2017	12/05/2017	13/05/2017	14/05/2017	15/05/2017	16/05/2017	17/05/2017	18/05/2017	19/05/2017	20/05/2017	21/05/2017	22/05/2017	23/05/2017	24/05/2017	25/05/2017	26/05/2017	27/05/2017	28/05/2017	29/05/2017	30/05/2017	31/05/2017	01/06/2017	02/06/2017	03/06/2017	04/06/2017
Device/Day	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
TBill1	7.40km	8.40km	8.30km	26.00km	33.20km	43.10km	0.00km	6.30km	46.40km	78.50km	48.40km	128.70km	13.10km	59.00km	5.60km	26.70km	28.40km	28.20km	34.20km	53.60km	11.30km	25.60km	28.10km	55.40km	25.90km	111.70km	38.30km	26.60km
TBill2	186.50km	17.80km	96.70km	2.50km	5.10km	82.80km	0.00km	0.00km	38.00km	1.10km	16.30km	62.60km	92.10km	85.10km	18.30km	29.10km	9.10km	81.80km	28.50km	0.00km	38.50km	0.00km	20.60km	0.20km	138.90km	106.50km	13.90km	1.70km
TBill3	60.40km	66.20km	21.90km	55.90km	59.60km	0.00km	0.00km	56.60km	58.40km	55.00km	55.60km	57.40km	0.00km	0.00km	68.20km	66.10km	54.40km	29.10km	57.90km	6.00km	1.00km	55.10km	56.90km	57.50km	58.80km	64.50km	14.50km	0.00km
TBill4	39.40km	45.80km	54.10km	22.90km	45.20km	53.50km	0.00km	38.00km	40.60km	42.30km	0.00km	151.00km	17.60km	0.00km	50.70km	68.90km	52.80km	114.90km	13.30km	16.70km	18.80km	39.60km	56.90km	50.50km	44.40km	64.50km	14.50km	0.00km
TBill5	56.80km	55.00km	55.70km	63.30km	37.40km	25.90km	173.70km	100.90km	42.30km	88.70km	72.50km	49.10km	0.00km	17.40km	88.90km	60.70km	55.30km	54.20km	560.80km	9.90km	588.60km	43.10km	95.50km	67.90km	65.10km	202.00km	90.00km	34.80km
TBill7	8.90km	24.40km	16.10km	20.60km	14.70km	116.90km	44.80km	19.10km	23.00km	15.30km	14.60km	53.70km	92.10km	87.80km	9.90km	18.90km	23.60km	14.70km	14.00km	98.90km	56.10km	11.60km	9.20km	13.60km	31.00km	8.20km	92.50km	62.60km
TBill8	16.30km	236.50km	31.50km	26.70km	21.80km	5.40km	11.40km	15.00km	15.50km	19.70km	14.70km	43.30km	4.00km	6.10km	14.00km	13.50km	16.00km	6.50km	18.10km	0.00km	14.70km	17.30km	16.30km	8.90km	16.00km	3.60km	15.40km	8.70km
TBill9	30.30km	7.40km	14.00km	18.70km	25.50km	0.00km	16.50km	0.00km	4.30km	12.70km	2.90km	12.10km	0.00km	0.00km	15.60km	0.90km	7.60km	62.00km	2.90km	0.00km	0.00km	10.30km	6.80km	20.30km	44.50km	27.30km	0.00km	37.20km
TBill10	15.40km	13.90km	18.50km	12.50km	13.00km	0.00km	222.70km	15.50km	16.80km	12.50km	12.70km	18.50km	0.00km	31.60km	30.30km	12.20km	20.00km	17.90km	14.50km	23.80km	213.00km	8.20km	0.00km	0.00km	0.00km	2.60km	26.70km	212.90km
TBill11	25.70km	17.20km	9.90km	13.00km	9.30km	18.70km	1.10km	9.70km	81.00km	3.30km	90.70km	20.00km	14.40km	5.20km	0.00km	91.60km	23.80km	17.40km	11.30km	54.40km	43.50km	15.10km	18.10km	11.00km	103.90km	23.30km	5.40km	14.00km
TBill12	83.20km	107.40km	86.40km	127.40km	84.20km	43.70km	18.80km	105.70km	86.50km	83.90km	105.90km	85.30km	35.30km	11.40km	85.30km	89.20km	118.80km	112.80km	120.50km	102.10km	19.90km	101.20km	119.50km	158.00km	91.60km	121.10km	110.30km	40.40km
TBill13	116.70km	8.20km	10.80km	20.70km	3.60km	113.30km	1.60km	4.10km	3.20km	3.10km	2.90km	6.90km	10.60km	31.00km	7.60km	5.60km	4.50km	3.70km	3.60km	1.20km	0.00km	4.10km	4.90km	4.60km	0.00km	0.00km	0.00km	0.00km
TBill14	0.00km	8.80km	12.20km	9.00km	8.20km	16.90km	7.00km	15.50km	79.30km	130.00km	252.10km	12.60km	0.00km	5.60km	384.90km	497.60km	13.00km	11.60km	9.30km	30.80km	100.20km	14.20km	125.20km	145.30km	17.90km	377.00km	18.30km	24.90km
TBill15	7.30km	12.30km	10.20km	9.80km	116.40km	2.30km	207.50km	20.90km	12.90km	12.50km	10.50km	77.30km	71.10km	0.00km	15.20km	13.40km	13.50km	7.90km	6.80km	0.00km	0.00km	14.30km	16.20km	64.70km	15.20km	44.60km	0.00km	0.00km
TBill16	78.30km	80.60km	78.20km	78.20km	79.50km	0.00km	0.00km	78.30km	77.40km	81.50km	77.20km	80.20km	11.70km	0.00km	79.00km	76.80km	76.10km	38.60km	78.30km	0.00km	0.00km	5.40km	0.00km	40.00km	0.00km	0.00km	16.60km	0.00km
TBill17	18.90km	41.00km	20.00km	31.90km	36.30km	9.70km	78.40km	54.00km	41.10km	42.50km	27.90km	33.50km	7.40km	4.50km	28.90km	33.50km	27.10km	28.80km	33.00km	20.10km	10.90km	36.70km	28.70km	40.00km	29.10km	23.40km	14.70km	16.50km
TBill18	95.30km	94.60km	93.20km	0.00km	197.00km	14.40km	76.50km	99.70km	90.40km	93.00km	43.50km	159.10km	15.90km	2.40km	96.20km	96.50km	103.80km	91.20km	98.30km	13.10km	0.00km	4.60km	6.90km	2.40km	181.40km	135.70km	16.50km	181.40km
TBill20	104.10km	0.00km	101.00km	6.20km	158.80km	0.00km	160.60km	105.90km	107.60km	7.30km	106.50km	72.20km	0.00km	0.00km	15.00km	0.00km	7.10km	12.00km	2.20km	74.70km	103.70km	117.70km	14.20km	107.40km	106.80km	17.80km	0.00km	5.50km
TBill21	11.20km	118.40km	10.70km	15.60km	7.70km	0.00km	0.00km	15.70km	12.60km	113.50km	140.60km	27.60km	96.40km	92.80km	99.30km	15.30km	24.50km	11.30km	402.80km	0.00km	0.00km	103.70km	0.00km	0.00km	30.50km	25.40km	342.50km	95.50km
GPS01	377.15km	7.55km	14.27km	5.14km	12.45km	13.31km	112.62km	8.86km	5.59km	6.23km	21.69km	5.37km	38.61km	43.56km	24.90km	6.02km	17.16km	45.87km	50.26km	0.00km	0.00km	52.34km	23.59km	23.56km	13.55km	20.84km	0.00km	20.36km
GPS02	17.89km	17.15km	397.52km	120.62km	3.22km	3.17km	6.91km	2.74km	280.55km	282.19km	105.02km	2.61km	0.00km	4.74km	281.66km	14.04km	277.13km	117.22km	24.93km	0.00km	0.00km	0.00km	280.09km	541.44km	0.00km	0.00km	0.00km	2.94km
GPS03	70.67km	61.14km	0.00km	0.00km	0.00km	7.79km	0.00km	67.70km	3.58km	19.31km	4.99km	0.00km	13.79km	8.08km	67.47km	69.93km	69.42km	73.25km	70.44km	57.58km	3.22km	67.35km	65.45km	67.95km	4.13km	0.00km	49.26km	1.21km
GPS04	56.15km	44.66km	44.47km	47.20km	44.61km	7.05km	0.53km	44.64km	46.79km	45.77km	47.06km	15.69km	37.87km	10.63km	47.36km	52.26km	52.86km	44.52km	57.24km	0.00km	16.97km	49.46km	44.67km	44.47km	55.87km	45.99km	11.39km	49.98km
TOTAL	1484.56km	1094.40km	1205.66km	733.86km	1016.78km	577.92km	1140.66km	884.84km	1207.81km	1249.90km	1274.26km	1174.77km	571.97km	506.91km	1534.29km	1358.15km	1095.97km	1025.46km	1713.17km	562.85km	1239.79km	798.35km	1037.80km	1485.12km	1071.65km	1420.33km	876.27km	837.19km
AVERAGE	64.55km	47.58km	52.42km	31.91km	44.21km	25.13km	49.59km	38.47km	52.51km	54.34km	55.40km	51.08km	24.87km	22.04km	66.71km	59.05km	47.65km	44.59km	74.49km	24.47km	53.90km	34.71km	45.12km	64.57km	46.59km	61.75km	38.10km	36.40km
MEDIAN	39.40km	24.40km	20.00km	20.60km	25.50km	9.70km	7.00km	19.10km	41.10km	42.30km	43.50km	43.30km	13.10km	6.10km	30.30km	29.10km	24.50km	29.10km	28.50km	9.90km	11.30km	17.30km	20.60km	40.00km	30.50km	25.40km	14.70km	16.50km

ADDENDUM J: STELLENBOSCH UNIVERSITY TRANSPORT MOBILITY STUDY QUESTIONNAIRE

INTERVIEWER ID:
ID VAN ONDERHOUDVOERDER:

_____

STUDENT NUMBER:
STUDENTENOMMER:

_____

STUDENT QUESTIONNAIRE FOR TYGERBERG'S MOBILITY STUDY
STUDENTEVRAELYS VIR TYGERBERG SE MOBILITEITSTUDIE

ABOUT YOURSELF
OOR JOUSELF

1a. What is your physical address during the term?
Address: Street name and number, or street intersection or landmark, suburb and town.

_____

Wat is jou fisiese adres gedurende die kwartaal?
Adres: Straatnaam en -nommer, straatkruising of baken, voorstad en dorp.

_____

1b. What is your parents' physical address?
Address: Street name and number, or street intersection or landmark, suburb and town.

Wat is jou ouers se fisiese adres?
Adres: Straatnaam en -nommer, straatkruising of baken, voorstad en dorp.

_____

_____

_____

2. What do you study?

Field of study: _____

Wat studeer jy?

Studieveld: _____

3. Where do you spend most of your time on campus? Please specify the name of the building(s) on campus where you usually study or attend classes.

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

---

Waar bring jy die meeste van jou tyd op kampus deur? Spesifiseer asseblief die naam van die gebou(e) op kampus waar jy gewoonlik studeer of klasse bywoon.

---

4. What is your gender?
Wat is jou geslag?

☐ Male *Manlik* ☐ Female *Vroulik*

5. How old are you?

Hoe oud is jy?

---

6. What is the highest level formal education you have completed?

☐ None
☐ Primary School
☐ Standard 6-8 / Grade 8-10
☐ Standard 9-10 / Grade 11-12
☐ Technikon
☐ University – Bachelor's degree
☐ University - Honours degree
☐ University – Masters degree
☐ University - Doctoral degree

☐ Other, please specify:

Wat is die hoogste vlak van formele opvoeding wat jy voltooi het?

☐ *Geen*
☐ *Laerskool*
☐ *Standerd 6-8 / Graad 8-10*
☐ *Standerd 9-10 / Graad 11-12*
☐ *Technikon*
☐ *Universiteit - Baccalareus-graad*
☐ *Universiteit - Honneursgraad*
☐ *Universiteit - Meestersgraad*
☐ *Universiteit - Doktorsgraad*

☐ *Ander, spesifiseer asseblief:*

---

7. Are you studying full-time or part-time?

☐ Full-time ☐ Part-time

Studeer jy voltyds of deeltyds?

☐ *Voltyds* ☐ *Deeltyds*

8. In what type of accommodation do you live during the term?

☐ University residence (go to question 11)
☐ Parents / family home
☐ Private rental house / flat (**<** 5 kilometres radius from campus)
☐ Private rental house / flat (**>** 5 kilometres radius from campus)

☐ Other, please specify:

_____

8. *In watter soort takkommodasie bly jy gedurende die kwartaal?*

☐ *Universiteitskoshuis (gaan na vraag 11)*
☐ *Ouers/familietuiste*
☐ *Private huurhuis/woonstel (radius van **<** 5 kilometer van die kampus af)*
☐ *Private huurhuis/woonstel (radius van **>** 5 kilometer van die kampus af)*

☐ *Ander, spesifiseer asseblief:*

_____

9. How many hours per day do you usually spend on campus?

_____ hours per day

9. *Hoeveel uur per dag bring jy gewoonlik op kampus deur?*

_____ *uur per dag*

10. What is the average distance you travel to campus per day? Please specify the one-way distance in kilometres.

_____ kilometres

Wat is die gemiddelde afstand wat jy per dag kampus toe reis? Spesifiseer asseblief die eenrigting-afstand in kilometer.

_____ *kilometer*

ABOUT PRIVATE TRANSPORT
OOR PRIVATE VERVOER

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

11a. Which of the following private motorised transport modes have you used during the past months to travel to campus, and how many times per week do you usually use this mode to commute to campus? More than one option can be ticked.
Watter van die volgende modusse vir private gemotoriseerde vervoer het jy die afgelope maand gebruik om kampus toe te reis en hoeveel keer per week gebruik jy gewoonlik hierdie modus om kampus toe te pendel? Meer as een opsie kan gemerk word.

☐ Car (as driver) _____ times per week
☐ Car (as passenger) _____ times per week
☐ Motorcycle _____ times per week
☐ Ride sharing (Car pool) _____ times per week
☐ None (go to question 21)

☐ Other, please specify:

_____ _____ times per week

☐ *Motor (as bestuurder)* _____ *keer per week*
☐ *Motor (as passasier)* _____ *keer per week*
☐ *Motorfiets* _____ *keer per week*
☐ *Saamryklub* _____ *keer per week*
☐ *Geen (gaan na vraag 21)*

☐ *Ander, spesifiseer asseblief:*

_____ _____ *keer per week*

11b. Do you have a vehicle that you use for travelling to and from campus?

☐ Yes ☐ No (go to question 11g)

Het jy 'n voertuig waarmee jy kampus toe en terug ry?

☐ *Ja* ☐ *Nee (gaan na vraag 11g)*

11c. If you have a vehicle and use it for travelling to and from campus, please provide details about the vehicle you use most frequently.
As jy 'n voertuig het waarmee jy kampus toe en terug ry, verskaf asseblief besonderhede oor die voertuig wat jy die meeste gebruik.

Make: _____
Maak:
Model: _____
Model:

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

Year: _____
Jaar:
Engine size: _____
Enjingrootte:
Annual kilometres travelled in this vehicle: _____
kilometres
Jaarlikse kilometer in hierdie voertuig afgelê: _____
kilometer

11d. Have you applied for and been allocated parking on campus?
Het jy aansoek gedoen om parkering op kampus en is dit toegeken?

☐ Yes ☐ No (go to question 11g)
☐ *Ja* ☐ *Nee (gaan na vraag 11g)*

11e. What type of parking was allocated to you?
Watter soort parkering is aan jou toegeken?

☐ Reserved ☐ Peripheral

☐ *Gereserveerd* ☐ *Periferie*

11f. You indicated you have allocated parking. How often do you use your vehicle for the following. More than one option can be ticked.
Jy het aangedui dat parkering aan jou toegeken is. Hoe dikwels gebruik jy jou voertuig vir die onderstaande? Meer as een opsie kan gemerk word.

☐ Driving between the residence and my parental home. _____ times per week
☐ Driving between the residence and shops (off campus). _____ times per week
☐ Driving to clinics and study-related locations. _____ times per week

☐ Other, please specify:

_____ _____ times per week

☐ *Ry tussen die koshuis en my ouerhuis* _____ *keer per week*
☐ *Ry tussen die koshuis en winkels (nie op kampus nie)* _____ *keer per week*
☐ *Ry klinieke en studieverwante plekke toe* _____ *keer per week*

☐ *Ander, spesifiseer asseblief:*

_____ _____ *keer per week*

11g. Would you be interested in joining a car pool that travels daily to the shops or gym in the area?

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

Sou jy belangstel om by 'n saamryklub aan te sluit wat daagliks na die winkels of gim in die area ry?

☐ Yes ☐ No
☐ *Ja* ☐ *Nee*

12. What are the main reasons for using private transport to go to campus? More than one option can be ticked. Please also rank all the options ticked, with 1 indicating your most important reason and 5 indicating the least important reason.
Wat is die hoofredes waarom jy private vervoer gebruik om by die kampus te kom? Meer as een rede kan gemerk word. Prioritiseer asb. ook al die opsies gemerk, met 1 jou belangrikste rede en 5 jou minste belangrike rede.

Private transport is essential to perform my studies.
Private vervoer is noodsaaklik vir my studie.

1.	2.	3.	4.	5.
O	O	O	O	O

Have to travel to and from Stellenbosch campus often.
Ek moet dikwels na en van die Stellenbosch-kampus af ry.

1.	2.	3.	4.	5.
O	O	O	O	O

Private transport is safer.
Private vervoer is veiliger.

1.	2.	3.	4.	5.
O	O	O	O	O

There is a lack of suitable alternatives.
Daar is 'n gebrek aan geskikte alternatiewe.

1.	2.	3.	4.	5.
O	O	O	O	O

Private transport is the most convenient option.
Private vervoer is die gerieflikste opsie.

1.	2.	3.	4.	5.
O	O	O	O	O

I have to drop off or pick up other people (e.g. family members) *en route*.
Ek moet ander mense (bv. familielede) op pad aflaai of oplaai.

1.	2.	3.	4.	5.
O	O	O	O	O

Private transport is the quickest option.
Private vervoer is die vinnigste opsie.

1.	2.	3.	4.	5.
O	O	O	O	O

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

I have to do shopping during/after work.
Ek moet inkopies gedurende/na werk doen.

1.	2.	3.	4.	5.
O	O	O	O	O

Private transport is the cheapest option.
Private vervoer is die goedkoopste opsie.

1.	2.	3.	4.	5.
O	O	O	O	O

Have to go to various places during the day.
Ek moet gedurende die dag na verskillende plekke toe gaan.

1.	2.	3.	4.	5.
O	O	O	O	O

Other, please specify: _____
Ander, spesifiseer asseblief: _____

1.	2.	3.	4.	5.
O	O	O	O	O

13. Which of the following reasons would encourage you to use your private vehicle less? More than one option can be ticked. Please also rank all the options ticked, with 1 indicating your most important reason and 5 indicating the least important reason.

Watter van die volgende redes sal vir jou as aanmoediging dien om jou private voertuig minder te gebruik? Meer as een rede kan gemerk word. Prioritiseer asb. ook al die opsies gemerk, met 1 jou belangrikste rede en 5 jou minste belangrike rede.

Reduction of my carbon footprint and my impact on the environment.
Vermindering van my koolstofvoetspoor en my impak op die omgewing.

1.	2.	3.	4.	5.
O	O	O	O	O

Reliable and affordable alternatives (e.g. car pooling, public transport).
Betroubare en bekostigbare alternatiewe (bv. saamryklubs, openbare vervoer).

1.	2.	3.	4.	5.
O	O	O	O	O

A decrease in the number of available parking bays on campus.
'n Afname in die getal beskikbare parkeerplekke op kampus.

1.	2.	3.	4.	5.
O	O	O	O	O

An increase in the cost of parking on campus.
'n Toename in die koste van parkering op kampus.

1.	2.	3.	4.	5.
O	O	O	O	O

Avoiding peak hour congestion.
Om verkeersknope in spitstyd te vermy.

1.	2.	3.	4.	5.
O	O	O	O	O

A reduction of my monthly costs.
'n Vermindering van my maandelikse koste.

1.	2.	3.	4.	5.
O	O	O	O	O

Other, please specify: _____
Ander, spesifiseer asseblief: _____

1.	2.	3.	4.	5.
O	O	O	O	O

14. Would you be willing to take part in ride sharing (car pooling)?
Sou jy bereid wees om van 'n saamryklub gebruik te maak?

☐ Yes ☐ No (go to question 20)

☐ *Ja* ☐ *Nee (gaan na vraag 20)*

15. Is it a requirement that the person with whom you could share a ride (car pooling) also study at Tygerberg Campus?
Is dit 'n vereiste dat die persoon saam met wie jy 'n rygeleentheid sal deel (saamryklub), ook op die Tygerberg-kampus studeer?

☐ Yes ☐ No
Ja *Nee*

16. Do you have to know the person with whom you could share a ride (car pooling) before you would consider it?
Moet jy die persoon ken saam met wie jy 'n rygeleentheid sal deel (saamryklub) voordat jy dit sal oorweeg?

☐ Yes ☐ No
Ja *Nee*

17. How many times per week (days) would you be willing to use ride sharing (car pooling)?
Hoeveel keer per week (dae) is jy bereid om deel van 'n saamryklub te wees?

_____ days per week

_____ *dae per week*

18a. Are you aware that the University has contracted with an independent contractor to give staff and students access to an online car-pooling platform, Maties Findalift?
Is jy daarvan bewus dat die Universiteit 'n kontrak met 'n onafhanklike kontrakteur het waarvolgens personeel en studente toegang het tot 'n aanlyn saamryklub-platform, Maties Findalift?

☐ Yes
Ja

☐ No (go to question 19)
Nee (gaan na vraag 19)

18b. Are you registered as a member of Maties Findalift?
Is jy geregistreer as 'n lid van Maties Findalift?

☐ Yes (go to question 20)
☐ *Ja (gaan na vraag 20)*

☐ No
☐ *Nee*

19a. What would motivate you to use the Maties Findalift platform?
Wat sal jou motiveer om van die Maties Findalift-platform gebruik te maak?

_____

_____

19b. What would discourage you from using the Maties Findalift platform?
Wat sal jou ontmoedig om van die Maties Findalift-platform gebruik te maak?

_____

20. Which of the following reasons would discourage you to use alternative modes of transport? More than one option can be ticked. Please also rank all the options ticked, with 1 indicating your most important reason and 5 indicating the least important reason.
Watter van die volgende redes sal jou ontmoedig om alternatiewe vervoermodusse te gebruik? Meer as een rede kan gemerk word. Prioritiseer asb. ook al die opsies gemerk, met 1 jou belangrikste rede en 5 jou minste belangrike rede.

The safety of public transport.
Die veiligheid van openbare vervoer.

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

1.	2.	3.	4.	5.
O	O	O	O	O

No bicycle paths.
Geen fietspaaie nie.

1.	2.	3.	4.	5.
O	O	O	O	O

Distance to nearest public transport stop is too far to walk.
Die afstand na die naaste openbarevervoer-halte is te ver om te stap.

1.	2.	3.	4.	5.
O	O	O	O	O

Having to rely on other people, for instance in the case of ride sharing.
Om op ander mense te moet staat maak, byvoorbeeld in die geval van saamry.

1.	2.	3.	4.	5.
O	O	O	O	O

Having to wait outside for public transport.
Om buite te moet wag vir openbare vervoer.

1.	2.	3.	4.	5.
O	O	O	O	O

Cycling or walking in the rain.
Fietsry of stap in die reën.

1.	2.	3.	4.	5.
O	O	O	O	O

Experiencing the same congestion that I would in my private vehicle.
Om dieselfde verkeersknope te ervaar wat ek in my private voertuig sou ervaar.

1.	2.	3.	4.	5.
O	O	O	O	O

The unreliability of public transport.
Die onbetroubaarheid van openbare vervoer.

1.	2.	3.	4.	5.
O	O	O	O	O

Overcrowded conditions in the minibus taxis.
Oorlaaide omstandighede in minibustaxis.

1.	2.	3.	4.	5.
O	O	O	O	O

Public transport is too expensive to use.
Openbare vervoer is te duur om te gebruik.

1.	2.	3.	4.	5.
O	O	O	O	O

Other, please specify: _____
Ander, spesifiseer asseblief: _____

1.	2.	3.	4.	5.

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

O O O O O

ABOUT PUBLIC TRANSPORT
OOR OPENBARE VERVOER

21a. Have you investigated options to commute by means of public transport?
Het jy opsies ondersoek om met openbare vervoer te pendel?

☐ Yes
☐ *Ja*

☐ No
☐ *Nee*

21b. What types of public transport are available to you to travel to campus? More than one option can be ticked.
Watter soort openbare vervoer is beskikbaar vir jou om te gebruik om by die kampus te kom? Meer as een opsie kan gemerk word.

☐ Bus
☐ Private shuttle
☐ None (go to question 24)

☐ Minibus taxi
☐ Train
☐ I do not know

☐ *Bus*
☐ *Private pendelbussie*
☐ *Geen (gaan na vraag 24)*

☐ *Minibustaxi*
☐ *Trein*
☐ *Ek weet nie*

22a. Which of the following public transport modes have you used to travel to campus during the past month, and how many times per week do you usually use this mode to commute to campus? More than one option can be ticked.
Watter van die volgende openbarevervoer-modusse het jy die afgelope maand gebruik om by die kampus te kom en hoeveel keer per week gebruik jy gewoonlik hierdie modus om kampus toe te pendel? Meer as een opsie kan gemerk word.

☐ Train _____ times per week
☐ Bus _____ times per week
☐ Minibus taxi _____ times per week
☐ Private shuttle _____ times per week
☐ None (go to question 23)

☐ Other, please specify:

_____ _____ times per week

☐ *Trein* _____ *keer per week*
☐ *Bus* _____ *keer per week*
☐ *Minibustaxi* _____ *keer per week*

☐ *Private pendelbussie* _____ *keer per week*
☐ *Geen (gaan na vraag 23)*
☐ *Ander, spesifiseer asseblief:*

_____ _____ *keer per week*

22b During the past month what type of ticket did you usually buy for the public transport modes you used for travelling to campus? Please also specify the price you paid for this type of ticket. After this question you can proceed to question 24.
Watter soort kaartjie het jy gewoonlik gedurende die afgelope maand gekoop vir die openbarevervoer-modusse wat jy gebruik het om by die kampus te kom? Spesifiseer asseblief ook die prys wat jy vir die soort kaartjie betaal. Beweeg ná hierdie vraag aan na vraag 24.

☐ Single ticket R_____ ☐ Return ticket R_____
☐ Week ticket R_____ ☐ Month ticket R_____

☐ Other, please specify: _____

☐ *Enkelkaartjie* R_____ ☐ *Retoerkaartjie* R_____
☐ *Weekkaartjie* R_____ ☐ *Maandkaartjie* R_____

☐ *Ander, spesifiseer asseblief:*

_____

23. You indicated there is public transport available, but that you have not used public transport to travel to campus during the past month. Which of the following public transport modes would you be willing to use, and how many times per week would you be willing to use this mode to commute to campus? More than one option can be ticked.

Jy het aangedui daar is openbare vervoer beskikbaar maar dat jy nie die afgelope maand van openbare vervoer gebruik gemaak het om by die kampus te kom nie. Watter van die volgende openbarevervoer-modusse sou jy bereid wees om te gebruik en hoeveel keer per week sou jy bereid wees om dit te gebruik om kampus toe te pendel? Meer as een opsie kan gemerk word.

☐ None
☐ Train _____ times per week
☐ Bus _____ times per week
☐ Minibus _____ times per week
☐ Private shuttle _____ times per week

☐ Other, please specify:

_____ _____ times per week

☐ *Geen*
☐ *Trein* _____ *keer per week*
☐ *Bus* _____ *keer per week*
☐ *Minibus* _____ *keer per week*
☐ *Private pendelbussie* _____ *keer per week*
☐ *Ander, spesifiseer asseblief:*

_____ _____ *keer per week*

ABOUT STELLENBOSCH UNIVERSITY SHUTTLE (MATIE BUS)
OOR UNIVERSITEIT STELLENBOSCH SE PENDELBUSSIE (MATIEBUS)

Description: A Matie Bus service is scheduled to operate during peak hours as a normal bus service for staff and students of Stellenbosch University. It will service a number of pick-up and drop-off points at set times both in the morning and in the afternoon. It will be a prepaid service at specific fares.

Beskrywing: Die Matie Bus-diens is geskeduleer om gedurende spitstye soos 'n normale busdiens te funksioneer vir personeel en studente van Universiteit Stellenbosch. Dit sal 'n getal optel- en aflaaipunte op vasgestelde tye in die oggend en middae diens. Dit sal 'n voorafbetaalde diens met spesifieke tariewe wees.

24. If a Maties Bus Service is implemented, would you be willing to consider using such a service?
As 'n Matie Bus-diens in werking gestel word, sal jy bereid wees om daarvan gebruik te maak?

☐ Yes
☐ *Ja*

☐ No (go to question 31)
☐ *Nee (gaan na vraag 31)*

25. How far would you be willing to walk to and from a pick-up point?
Hoe ver sal jy bereid wees om na en van 'n oplaaipunt te loop?

_____ Minutes *minute*

26. Between what times do you need to be picked up in the morning in order to be on campus in time? Assume that the pick-up point is within 500 metres from your home.

Tussen watter tye moet jy soggens opgelaai word om betyds op kampus te wees? Neem aan die oplaaipunt is binne 500 meter van jou huis.

Earliest pick-up time _____ hours _____ minutes

Latest pick-up time _____ hours _____ minutes

Vroegste oplaaityd _____ *uur* _____ *minute*

Laatste oplaaityd _____ *uur* _____ *minute*

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

27. Between what times do you need to be dropped off in the afternoons? Assume that the drop-off point is within 500 metres from your home.
Tussen watter tye moet jy smiddae afgelaai word? Neem aan die aflaaipunt is binne 500 meter van jou huis.

Earliest drop-off time _____ hours _____ minutes

Latest drop-off time _____ hours _____ minutes

Vroegste aflaaityd _____ *uur* _____ *minute*

Laatste aflaaityd _____ *uur* _____ *minute*

28. If such a services exists, it will function on a prepaid basis. What would you be willing to pay per trip?

As so 'n diens bestaan, sal dit op 'n voorafbetaal-grondslag werk. Hoeveel sou jy bereid wees om per rit te betaal?

R _____ per trip (one way)

R _____ *per rit (een rigting)*

29. Would you be more willing to consider using such a service if there were more than one specific pick-up time per peak period? For instance, if you miss the first shuttle you could still take the second one.

Sou jy meer bereid wees om die gebruik van so 'n diens te oorweeg as daar meer as een vasgestelde oplaaityd per spitstyd sou wees? So byvoorbeeld sou jy as jy te laat is vir die eerste bus, steeds die tweede een kan haal.

☐ Yes
☐ *Ja*

☐ No
☐ *Nee*

30a. Will you use a shuttle service between Tygerberg Campus and Stellenbsoch Campus?
Sal jy 'n pendeldiens tussen die Tygerberg-kampus en die Stellenbosch-kampus gebruik?

☐ Yes
☐ *Ja*

☐ No (go to question 31)
☐ *Nee (gaan na vraag 31)*

30b. How many times per week?
Hoeveel keer per week?

_____ times per week
_____ *keer per week*

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

30c. What time of the day?
Watter tyd van die dag?

_____ (leave Tygerberg Campus)
_____ (return to Tygerberg Campus)

_____ *(verlaat die Tygerberg-kampus)*
_____ *(keer terug na die Tygerberg-kampus)*

ABOUT NON-MOTORISED MODES OF TRANSPORT
OOR NIEGEMOTORISEERDE VERVOERMODUSSE

31. Which of the following alternative transport modes have you used to travel to campus during the past month and how many times per week do you usually use this mode to commute to campus? More than one option can be ticked.
Watter van die volgende niegemotoriseerde vervoermodusse het jy die afgelope maand gebruik om by die kampus te kom en hoeveel keer per week gebruik jy dit gewoonlik om kampus toe pendel? Meer as een opsie kan gemerk word.

☐ Walking _____ times per week (go to question 35)
☐ Cycling _____ times per week (go to question 35)
☐ Longboard / Skateboard _____ times per week (go to question 35)
☐ None

☐ Other, please specify:

_____ _____ times per week

☐ *Stap* _____ *keer per week (gaan na vraag 35)*
☐ *Fietsry* _____ *keer per week (gaan na vraag 35)*
☐ *"Longboard" / skaatsplank* _____ *keer per week (gaan na vraag 35)*
☐ *Geen*

☐ *Ander, spesifiseer asseblief:*

_____ _____ *keer per week*

32. Would you consider walking to campus and how many times per week?
Sou jy dit oorweeg om kampus toe te stap en hoeveel keer per week?

☐ Yes _____ times per week
☐ No
☐ No, I live too far way

☐ *Ja* _____ *keer per week*
☐ *Nee*
☐ *Nee, ek woon te ver*

33. Would you consider cycling to campus and how many times per week?
Sou jy dit oorweeg om met 'n fiets kampus toe te ry en hoeveel keer per week?

☐ Yes _____ times per week
☐ No

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php

☐ No, I live too far way (go to question 35)

☐ *Ja* _____ *keer per week*
☐ *Nee*
☐ *Nee, ek woon te ver (gaan na vraag 35)*

34. What amenities do you require before considering to cycle to campus?
Watter soort geriewe moet daar wees voor jy dit sal oorweeg om met die fiets kampus toe te ry?

☐ Showers
☐ Secure bicycle sheds (uncovered)
☐ Secure bicycle sheds (covered)
☐ Locker facilities
☐ Other, please specify:

_____

☐ *Storte*
☐ *Veilige fietshokkies (nie onderdak nie)*
☐*Veilige fietshokkies (onderdak)*
☐ *Sluitkasgeriewe*
☐*Ander, spesifiseer asseblief:*

_____

ABOUT THE TRIP DIARY
OOR DIE RITDAGBOEK

35. Did you travel to campus as you usually travel on Day 1 of the Trip Diary?
Het jy op dag 1 van die ritdagboek op dieselfde manier kampus toe gereis as gewoonlik?

☐ Yes
☐ No, please specify why:

_____

_____

☐ *Ja*
☐ *Indien nee, spesifiseer asseblief hoekom nie:*

_____

36. Did you travel to campus as you usually travel on Day 2 of the Trip Diary?
Het jy op dag 2 van die ritdagboek op dieselfde manier kampus toe gereis as gewoonlik?

☐ Yes
☐ No, please specify why:

_____

_____

☐ *Ja*
☐ *Indien nee, spesifiseer asseblief hoekom nie:*

_____

_____

THANK YOU VERY MUCH FOR YOUR YOUR TIME AND COOPERATION
BAIE DANKIE VIR JOU TYD EN SAMEWERKING

More Information: http://www0.sun.ac.za/sustainability/pages/english/home.php